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# Power for Law Making

PRINCIPAL STATE BUILDINGS AT SPRINGFIELD, ILL., FURNISHED LIGHT, HEAT AND POWER FROM MODERN PLANT EQUIPPED WITH UNIFLOW ENGINES AND CROSS DRUM, WATER-TUBE BOILERS

WHILE A POWER PLANT cannot be held responsible for the laws of a state, the kind of laws which we get is unquestionably influenced by the degree of comfort and convenience which surrounds the law-making men. It is, therefore, entirely appropriate that we should head this article "Power for Law Making."

Demands for increased load upon the old power plant serving the state buildings at Springfield, Ill., and plans for a new building to be served, made the installation of a new and modern power plant of increased size the logical solution to the problem. Consequently, the entire equipment of the old plant was taken out, leaving nothing but the 4 walls of the building and new machinery was put in. During this period of reconstruction, from October, 1915, to July, 1916, the plant continued in service working at times under the most severe conditions.

## THE BUILDING

AS INDICATED above the power plant is in a separate building across the street, north of the Capitol building.

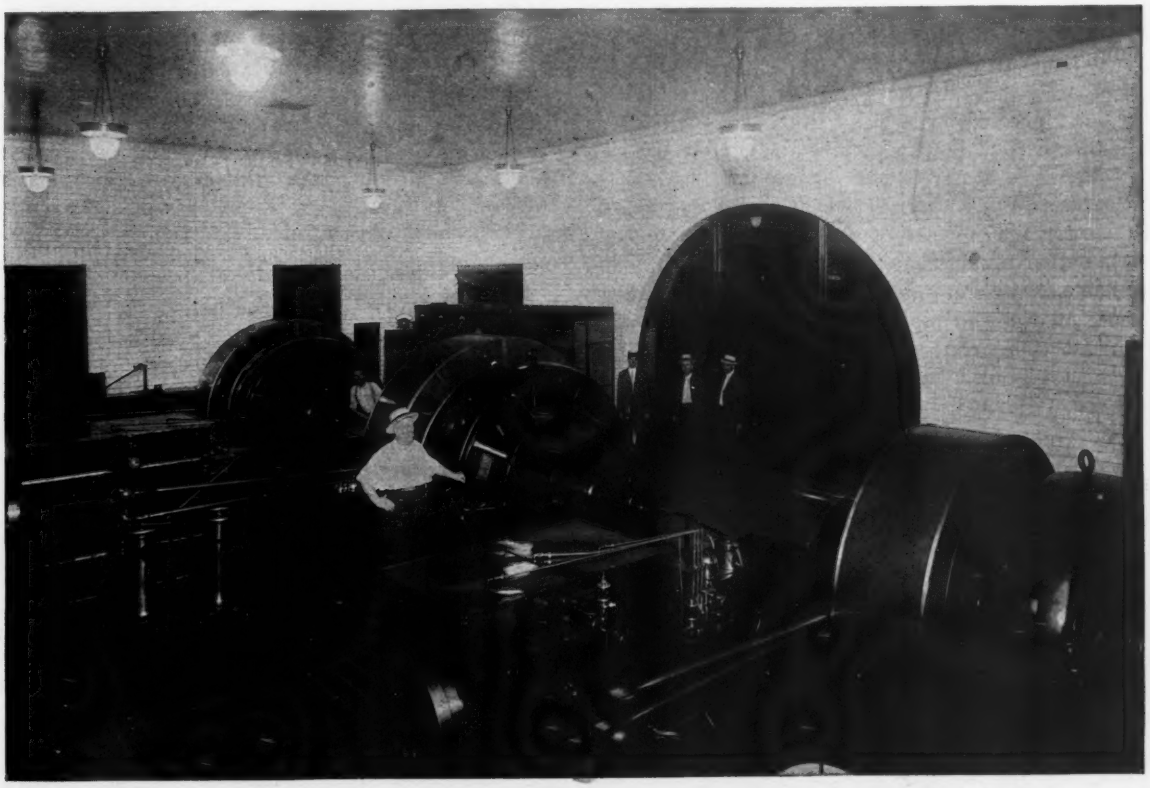

FIG. 2. VIEW IN THE ENGINE ROOM SHOWING VALVE GEAR SIDE OF UNIFLOW ENGINES

FIG. 1. EXTERIOR OF PLANT FROM CAPITOL GROUNDS AND BUILDINGS WHICH IT SERVES

It is a single story structure with stone walls which are built upon bed rock, the roof and floors being reinforced concrete supported on steel girders. The engine room floor is at ground level with pipe tunnels beneath, but the boiler room floor is at a lower level and beneath the boiler room is a tunnel accommodating the lower run of the coal and ash conveyor and feed water piping.

Glazed tiling finish for the walls, large windows and Brascolite semi-direct lighting fixtures, together with the absence of overhead piping, add greatly to the attractiveness of the engine room. In the boiler room light is furnished by inclosed lamps with porcelain shades and the walls are painted a serviceable gray color with boiler fronts and other machinery to match.

From the exterior, the most striking feature of the plant is the smoke stack which is 250 ft. high with an interior diameter at the top of 8 ft. 3½ in. It is constructed of pearl gray Chinchilla radial pressed brick for the outside wall, and lined 80 ft. with firebrick. The stack is protected by a lightning rod with 4 branches at the top, each branch having 6 platinum points to collect the lightning. In shape, the stack resembles a large column converging toward the top and is much higher and larger than the requirements of the plant demand, but with the old plant the flue gases were at times blown directly into the assembly halls, causing annoyance, and the new stack is built to overcome this trouble.

### Service Handled

This plant furnishes light, heat and power to the Capitol Building, Supreme Court and the Armory and Arsenal, also light for the Governor's Mansion, as shown below. An additional load will be cared for when the Educational Building is completed, appropriation for which has already been voted.

### Services Rendered to Buildings

CAPITOL BUILDING:

32,000 sq. ft. of radiator heating surface.
5, 30-hp. motor driven passenger elevators.
1, 30-hp. motor driven push button passenger elevator.
3000, 60-w. incandescent lamps.
45, 750-w. arc lamps.
400, 250-w. incandescent lamps.
20, 500-w. incandescent lamps.
20, 250-w. incandescent lamps.
2, 7½-hp. ventilating fan motors.
2, 5-hp. ventilating fan motors.
60 motors from 60-w. to ½-hp., stamping and multigraph work.
8, 1,000,000-c.m. and 2, 750,000-c.m. cables carry the current.

SUPREME COURT BUILDING:

Exhaust steam for heating.
1250, 50-w. incandescent lamps.

30, 60-w. fan motors.
1, 30-hp. Otis elevator.
3, 6-hp. Otis push button elevators.
8 miscellaneous 8-hp. motors for pumps, fans, etc.
1, 20-hp. motor for ventilating fan.
4, 1,000,000-c.m. cables carry the current.

ARMORY AND ARSENAL BUILDING:

Exhaust steam for heating.
480, 50-w. incandescent lamps.
4, 5-w. fans.
2, 2½-hp. and 1, 3-hp. motors for testing road materials.
5, 750-w. arc lamps.
5, 2-hp. motors miscellaneous use.
30, 400-w. incandescent lamps.
2, 500,000-c.m. cables and 2, 000 wires carry the current.

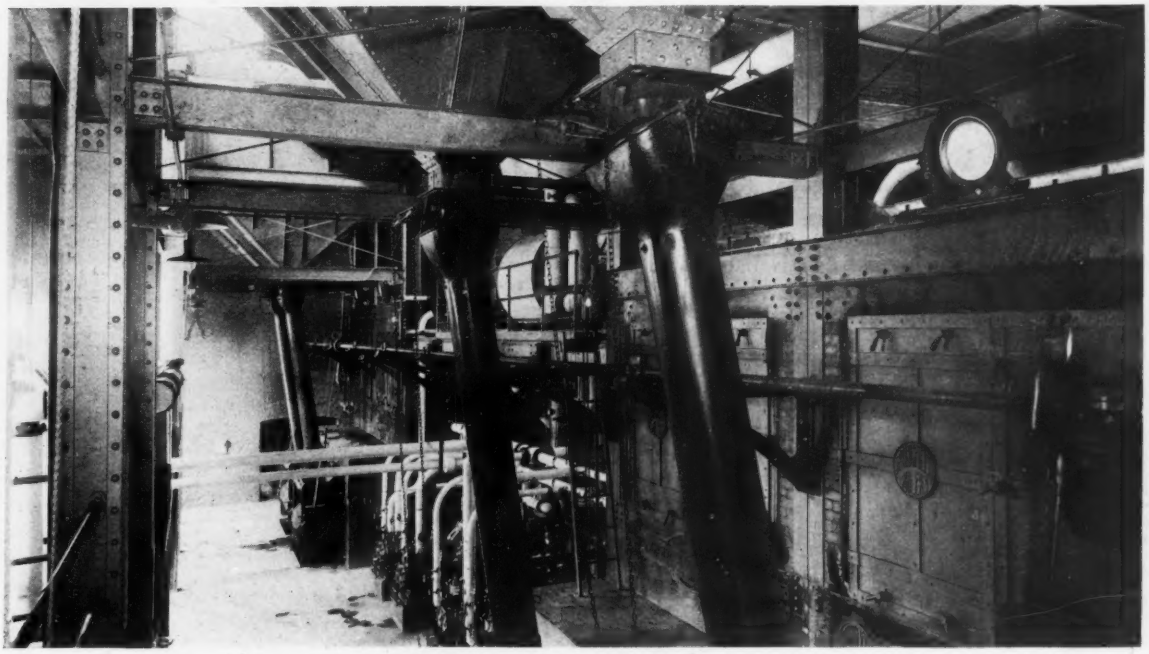

FIG. 3. BOILER ROOM AS SEEN FROM ENGINE ROOM DOOR

EXECUTIVE MANSION:

240, 50-w. incandescent lamps.
10, 60-w. fan motors.
2, 0000 wires carry the current.

POWER HOUSE MOTORS:

3, 5-hp.; 1, 12-hp.; 1, 8-hp.; for operating coal and ash conveyor, coal crusher and stokers.
750,000-c.m. cable carries current for power-house motors and lights.

## Coal Handling

Coal is brought to the plant in auto-trucks or wagons and dumped into a receiving hopper which discharges into a coal crusher or direct to the bucket conveyor which elevates it to the two bunkers over the boilers, each having 50 tons' capacity.

Beneath the boilers are ash hoppers and reclaiming hoppers which discharge into the conveyor, the reclaimed coal being delivered to the coal bunkers while the ashes go to a bin of 60 cu. yd. capacity directly above the coal receiving hopper, so that when wagons unload their coal they are in position to load up with ashes. Soot spouts from behind the bridge walls discharge into the ash pits and facilitate the cleaning of the combustion chambers.

Coal is delivered to the plant daily, being weighed on wagon scales as it is received. It is not the intention to keep a great amount of coal in storage, but provision is made for storing a considerable amount which would tide the plant over interruptions in delivery.

The conveyor has a capacity of 25 tons an hour and was built by the Link-Belt Co.

## Boilers

Steam is generated in 4 cross-drum, water-tube boilers made by the Springfield Boiler & Mfg. Co. Each boiler has a rating of 325 hp. and is designed for a working pressure of 200 lb., being constructed entirely of steel. The headers are of the sectional sinuous type, each individual front header being suspended from the framework of the boiler setting while the rear headers rest upon a ball bearing support on the foundation.

By grouping the tubes in fours with hand holes opposite each group, the number of hand holes is reduced which facilitates the process of cleaning. Each header section is likewise connected to the steam and water drum by 4 tubes which enter the drum in practically a radial direction, thus reducing strains and providing free and easy circulation. A baffle over the front header connecting tubes deflects the wet steam downward; this entire construction gives a large evaporation surface and together with the dry pan provides dry steam at the outlet.

Feed water enters a feed pan, from which it overflows at high temperature to the boiler drum, while along the bottom of the feed pan a perforated pipe extends

and is used to discharge precipitates which gather here. Besides this, 2 blowoff connections are made to the mud drum. In each of the blowoff pipes a Simplex seatless blowoff valve backed by a Johnstone floating gate is provided, the discharge being made to a blowoff basin with vent to atmosphere and connection through a cooling basin to sewer.

Foster superheaters are placed between the first and second passes of the boiler, designed to give 75 deg. of superheat at rated boiler load. The boilers are also provided with Vulcan soot cleaners, fusible plugs with whistle and stop valve, and safety valves with mufflers besides the usual mountings.

Illinois chain grate stokers serve these boilers and are operated from an overhead shaft driven either by motor or small engine. Excellent means for regulating the fire are provided in the dampers under the furnace side of the grate as indicated in the illustration.

Draft will be controlled by a damper regulator operating dampers in the main breechings while each boiler has its individual hand-operated damper. Draft readings are indicated by Ellison draft gages, one of which is provided for each boiler.

The water back consists of an extra heavy pipe inside of which is another pipe of smaller diameter. Water is taken from the back header, passes through the inner tube to the opposite side of the furnace and returns through the outer tube and is delivered to the front header.

Feed water is taken principally from the city mains, but in winter the returns from the heating system form a good percentage. Heating returns are delivered

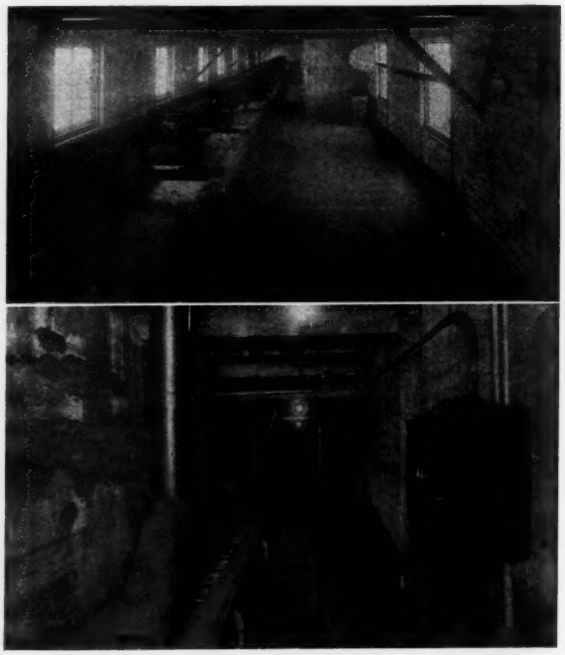

FIG. 5. UPPER AND LOWER RUNS OF COAL CONVEYOR

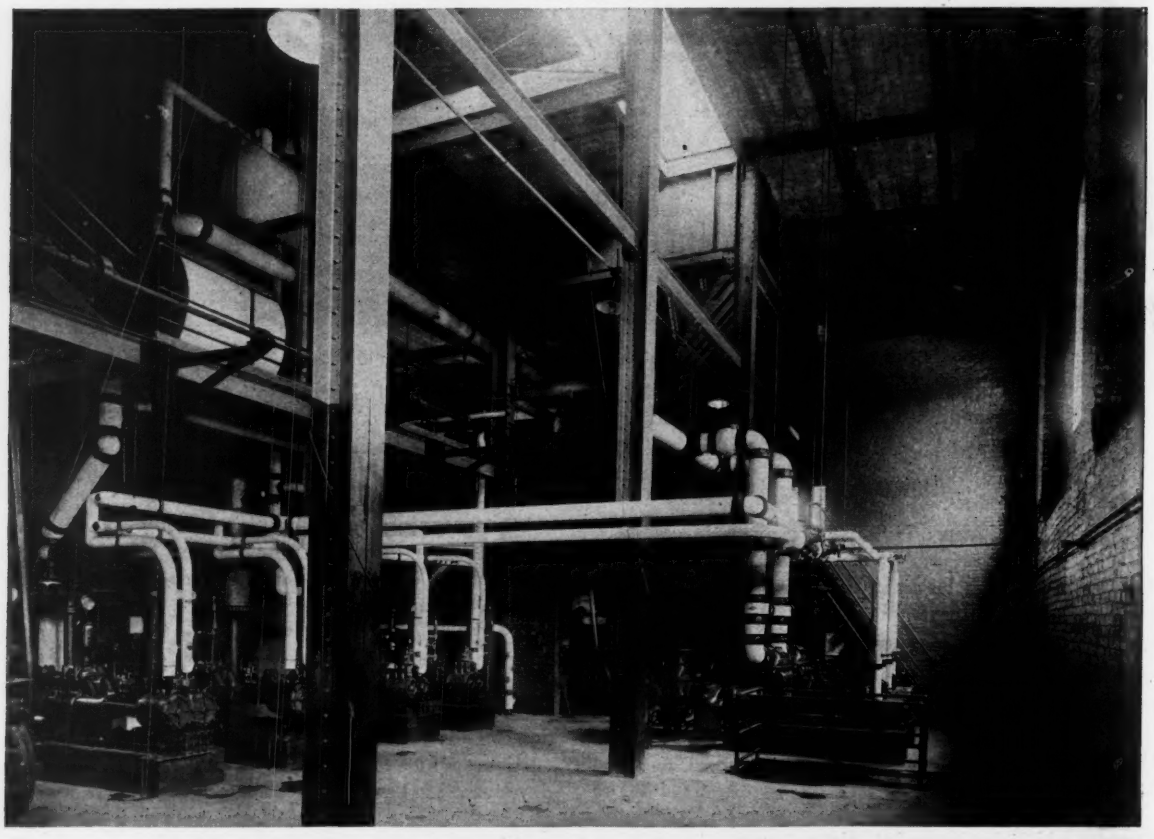

FIG. 4. BOILER FEED, SERVICE AND VACUUM PUMPS, HEATER AND RECEIVER

by 2 Blake & Knowles simplex vacuum pumps, 10 by 16 by 18 in., to a receiver tank which feeds by gravity to the Blake & Knowles open horizontal feed water heater. The heater has a capacity of 53 cu. ft., is rated at 1200 hp., and is located 18 ft. above the feed pumps. It takes exhaust steam from the vacuum pumps, house pumps, boiler feed pumps and the stoker engine, and heats the water to approximately 212 deg. F. (100 deg. C.).

City water delivered to the heater is measured by a Kennicott water weigher, the heating returns, however, are not measured but go direct to the heater. From the heater, 2 Worthington outside packed plunger pumps, 10 by 6 by 10 in., deliver to the feed water header. Provision is also made for delivering cold water direct from the mains to an auxiliary cold water header. These pumps are under the control of Foster pump governors, and Hills McCanna oil pumps furnish lubrication. While

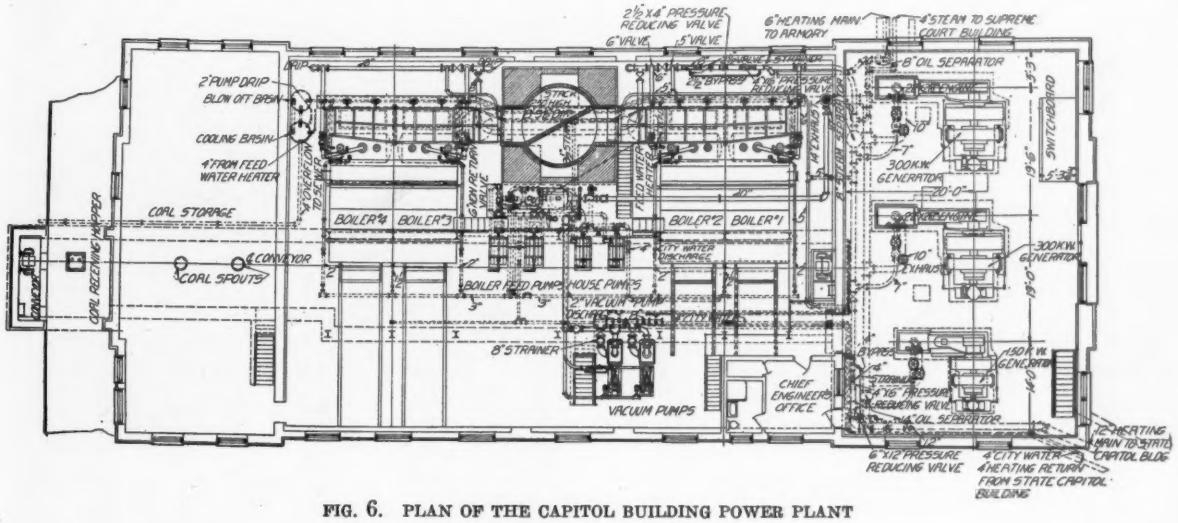


FIG. 6. PLAN OF THE CAPITOL BUILDING POWER PLANT

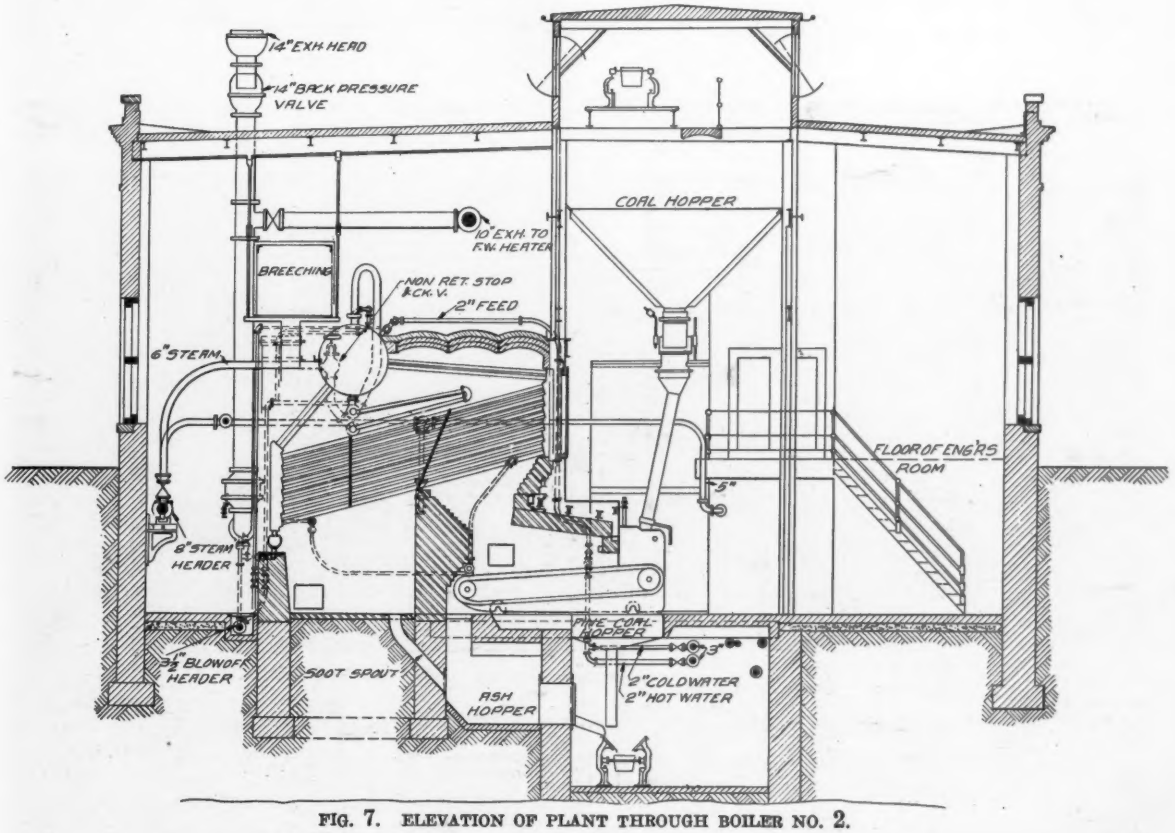


FIG. 7. ELEVATION OF PLANT THROUGH BOILER NO. 2.

the boilers are not yet equipped with feed water regulators, this will be done before the plant is completed. The efficiency guarantee of the boilers is the evaporation of 8 lb. of water from and at 212 deg. F. per pound of coal having a heat value of 11,000 B.t.u.

7½ by 7 by 10 in. and deliver to tanks in the attic of the Capitol Building against a pressure of 150 lb.

### Engine Room

Three generating units are installed for handling the electrical load of the plant. These consist of Chuse

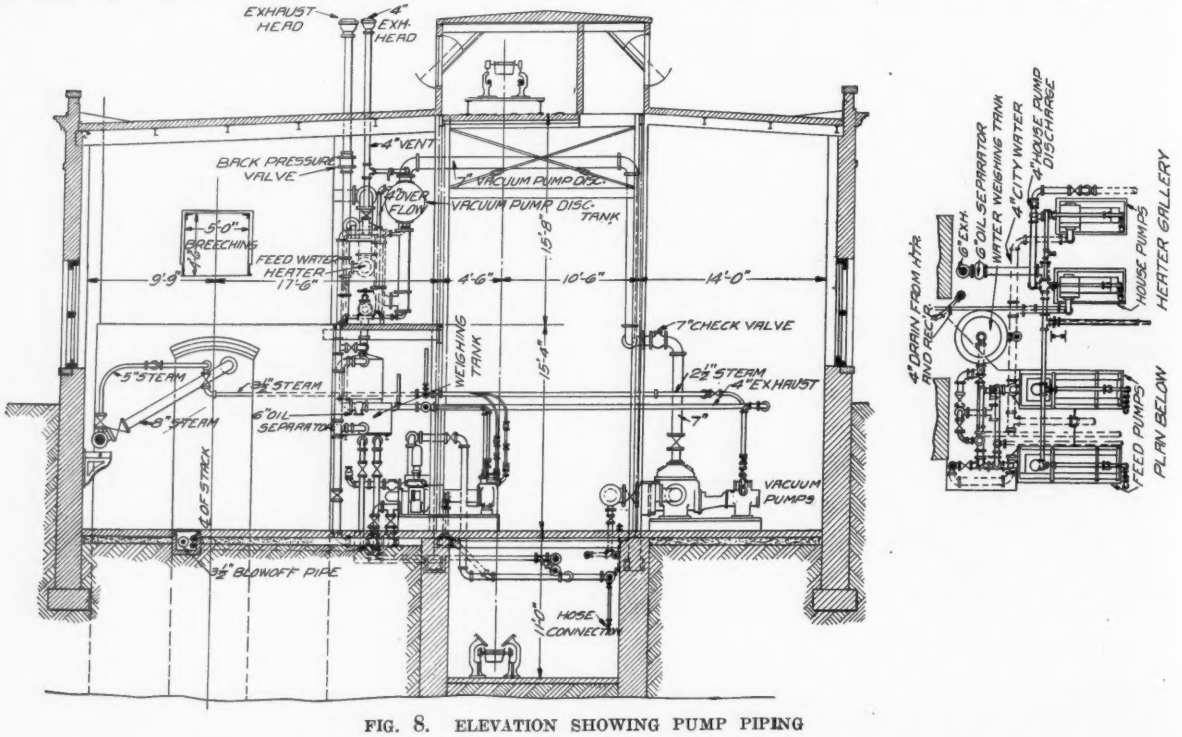


FIG. 8. ELEVATION SHOWING PUMP PIPING

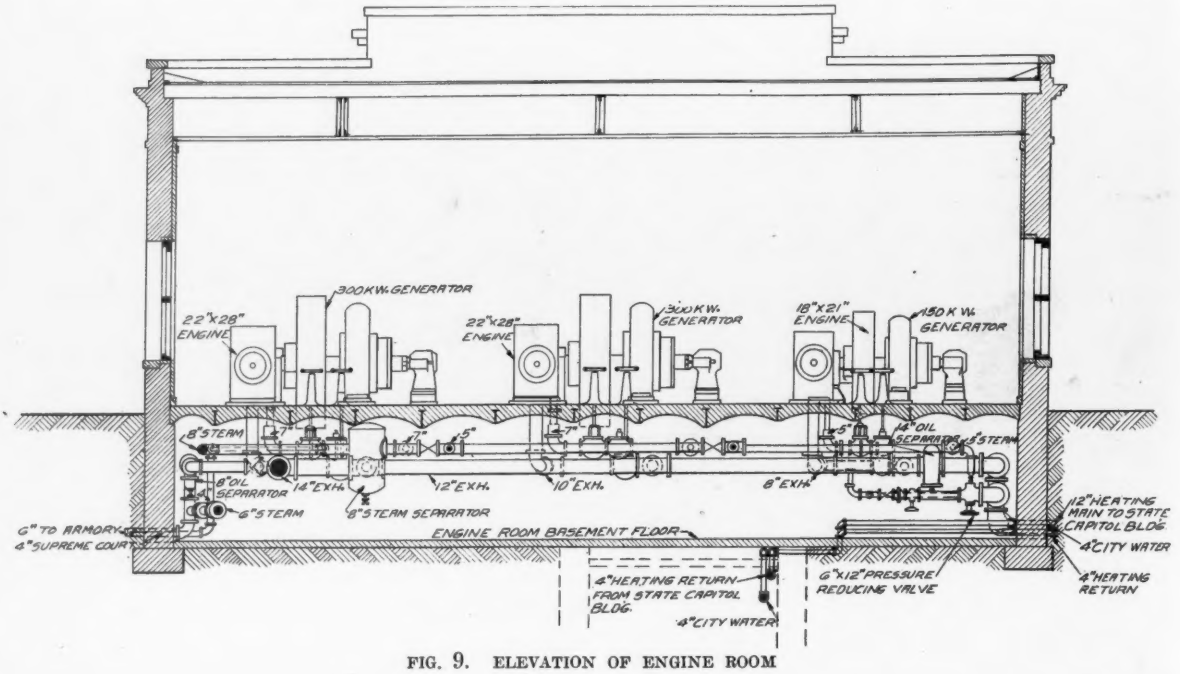


FIG. 9. ELEVATION OF ENGINE ROOM

Water for the upper floors of the Capitol Building is pumped from the city mains by 2 Worthington pumps located in the boiler room. These are duplex pumps

poppet-valve Uniflow engines direct connected to Western Electric Co. generators. One engine is 18 by 21 in. and runs at 200 r.p.m.; the generator which it drives

is rated at 150 kw. and delivers direct current at 125 v. The other engines are each 22 by 28 in. and run at 150 r.p.m. driving 300-kw. generators. The small unit is run nights and Sundays when the load is light, while the day load will be taken care of by one of the 300-kw. units leaving, under present conditions, one unit in reserve.

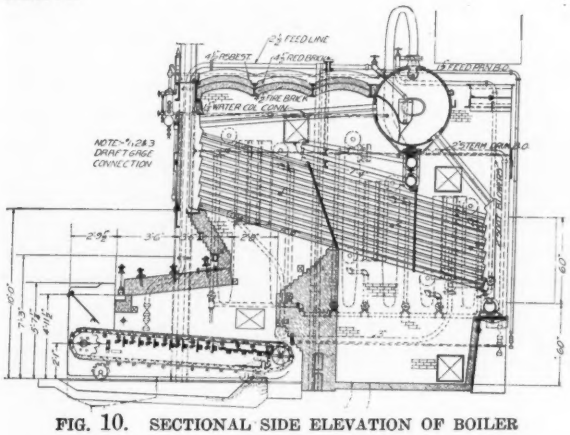


FIG. 10. SECTIONAL SIDE ELEVATION OF BOILER

Each engine is equipped with a Locke engine stop with 5 stations; Hills-McCanna 3-feed oil pumps supply general lubrication, while the splash system is used on the crankpins with the O'Keefe method of cooling the oil.

At present the pressure carried on the boilers is 175 lb., while the superheat is 100 to 120 deg. F., but it is expected to increase the pressure to 200 lb. when the plant is put into regular operation. During the heating season the engines will exhaust into the heating systems against a pressure ranging from 0 gage to 3 lb. vacuum. The Webster vacuum heating system is employed throughout, the total radiator surface being 70,000 sq. ft. The vacuum at the pumps is 20 in., while the engines exhaust against practically atmospheric pressure.

During the winter season the heat and light loads are quite evenly balanced, but in the summer about half the exhaust steam goes to atmosphere, the rest being used for heating water for domestic purposes.

Control of the electrical output is handled from a 6-panel switchboard, 3 panels of which are for the generator instruments, 2 for the feeder switches and instruments and one for the meters; space is left for additional panels as required. The instruments employed are I. T. E. circuit breakers, Weston volt and ammeters and Sangamo wattmeters. Each building served has a wattmeter on the board.

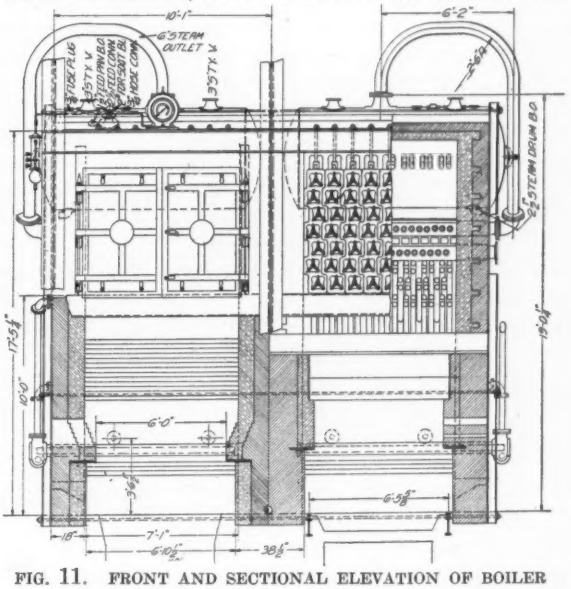


FIG. 11. FRONT AND SECTIONAL ELEVATION OF BOILER

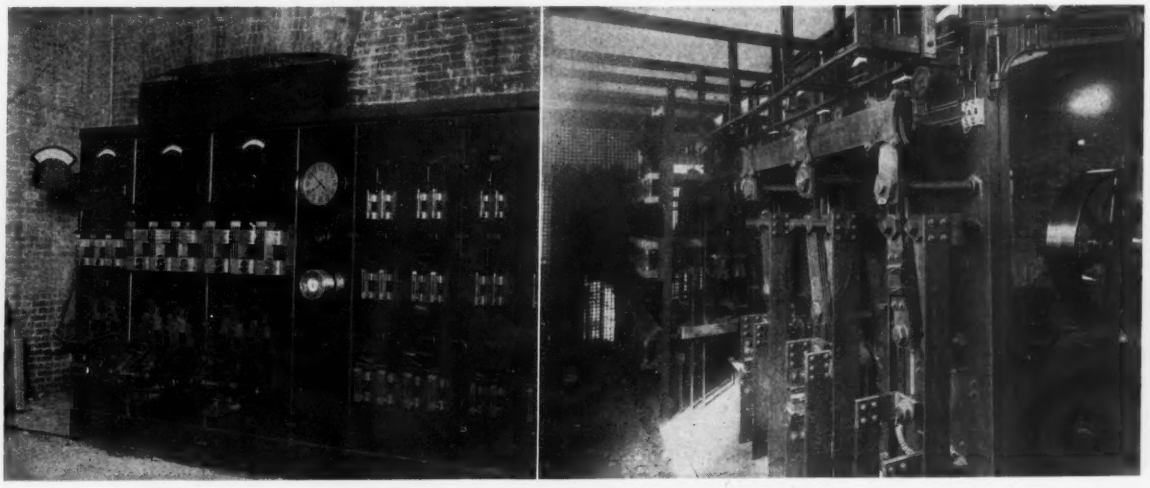

FIG. 12. FRONT AND REAR VIEWS OF THE SWITCHBOARD

A gage board will also be erected in the engine room upon which will be mounted all pressure and temperature indicating and recording gages.

### Steam Piping

From the boiler drums the steam passes through the superheaters from which it is led to the headers through 6-in. pipe. In the lead an angle non-return stop and check valve made by the Foster Engineering

Co. is placed at the boiler in the highest point of the lead and a globe valve is placed at the header. Owing to the location of the chimney it was necessary to divide the main steam header in the boiler room into 2 sections connected by a loop through a passageway under the chimney. That section of the header serving boilers Nos. 3 and 4 is 6-in., but the loop and the section serving boilers Nos. 1 and 2, as well as the engine room header, is 8-in. These headers are well provided with drip pockets and a steam separator in the engine room header insures the engines against water and the necessary bends in the headers are made with long radii to reduce friction and provide for expansion. All steam piping is beneath the floor in the engine room, the header being on the same level in the boiler room.

An auxiliary header is a 5-in. line with connections to both sections of the main boiler room header through pressure reducing valves. This line furnishes steam to all pumps and engines except the 3 main units. The exhaust header in the engine room supplies steam for heating the buildings, the connections being made from the ends of the header where steam separators are located to remove moisture. Two 4-in. bypass lines are provided for delivering high-pressure steam through reducing valves into the heating systems in case the supply of exhaust steam is insufficient.

Exhaust to atmosphere is through a 14-in. stack extending through the roof and provided with a back-pressure valve and exhaust head. Connection is made from the main exhaust to the heater through a 10-in. pipe.

Steam pipes are covered with asbestos sponge felt 3 in. thick, bound with heavy canvas and all exposed parts of the boiler drums are covered with the same material laid in 2 layers, each 1½ in. thick.

It is due largely to the efforts of Secretary of State, Lewis G. Stevenson, that this reconstructed plant has been made possible while the engineering work was done in the office of Martin C. Schwab. The plant is operated under the directions of Chief Engineer A. W. Daily, through whose efforts continuous service was maintained during the entire period of reconstruction.

# Engine Governors III*

SPECIAL TYPES OF SHAFT GOVERNORS. BY E. C. WELLS

ILLUSTRATED in Fig. 11, is the centrifugal form of governor used on McIntosh & Seymour engines. In this figure the centrifugal weights, W, W, are in their extreme outer position, and have pulled ahead the eccentric, to which they are connected by links, and which is free to revolve on the shaft sufficiently to cut off the steam entirely from entering the cylinder. This condition is approached when the engine is running and the load is thrown off. The centrifugal force of each weight is opposed in a direct manner by a leaf spring through a hardened steel pin with a ball-and-socket bearing at the end of the spring at the center of gravity of weight, so that there is no friction or pressure due to this force upon the pin upon which the weight swings. This permits the use of very heavy weights, having great centrifugal force and making the governor powerful. The tension pins, F, F, between springs and centrifugal weights, are arranged to telescope, in order that they can be adjusted to secure proper sensitiveness, for by lengthening or shortening these pins the governor can be made to regulate with more or less closeness. The speed of the engine can be changed by changing the weight of the pieces provided for that purpose in holes in the centrifugal weights. As the exhaust valves of these engines are driven from fixed eccentrics, the governor regulates the cutoff valves only by changing the position of the eccentric.

The Rice governor shown in Fig. 12 is a peculiar type of governor. The weights, W, W, are linked to the socker arm, A, in such a manner that the outward movement of the weights throws the right-hand end of the arm downward and the left-hand end up, rotating the spindle to which the arm is keyed.

The influence of centrifugal force is opposed by a double leaf spring, S. The shaft to which the rocker arm, A, is keyed, passes through the center of the crankpin, the governor being housed on the rear side of the crank disk. The rocker shaft carries on its outer end a crank, which in turn carries a hollow wristpin, to which the valve rod is attached. The movement of the weights rocks the shaft in one direction or the other, altering the distance of the valve rod wristpin from the center of the engine shaft, thus changing the throw of the valve.

The Harrisburg engine governor is shown in Fig. 13. Its governing parts consist of 2 governor arms on which are mounted both the centrifugal and inertia weights. The large weights are the centrifugal and the small ones are moved by inertia. These arms are linked together to the eccentric, which is shifted around the shaft as the speed increases, and are kept in balance by 2 coiled springs made with screwed plug connections. The ends of the governor arms are hollow, for adjusting weights, by means of which the speed of the engine may be changed. The governor is symmetrical on both sides of the shaft, eliminating the resulting effect of gravity action, the friction of the governor being lessened by the use of roller bearings.

A type of governor used by the Erie City Iron Works on their 4-valve engine is shown in Fig. 14, in which a mass of metal is used to accentuate and quicken the action of the governor, and in which are combined in one mass the inertia feature and the centrifugal weight. This mass is suspended upon roller bearings, the action of the centrifugal weight and the inertia weight being controlled by a leaf spring. In case the engine, from increase of load, tends to slow down, the inertia of the parts acts as a momentary aid to the governor

*Parts I and II dealt with fundamental principles of pendulum and shaft governors.

spring, carrying the weight forward and toward the center, increasing the travel of the valve and giving later cutoff.

As the speed of the engine tends to increase, the inertia weight tends to fall back, increasing the effect of the centrifugal weights in shortening the valve travel and cutting off steam earlier in the stroke. In this

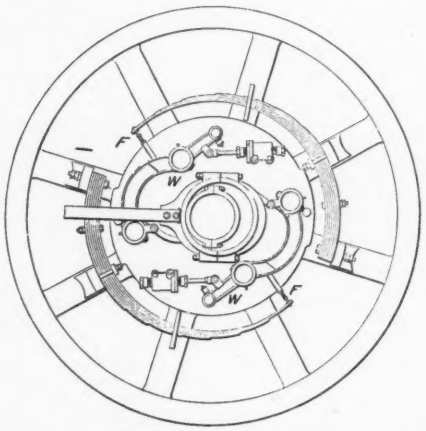


FIG. 11. GOVERNOR OF MC INTOSH & SEYMOUR ENGINE

form of governor, it will be noticed, a leaf spring is employed. The advantages claimed for it are that, as each leaf can be tempered separately, it does away with that fault in springs of more complicated type, whose form sometimes prevents the uniformity of temper, and hence perfect regulation. In these governors provision is made for a reversed action, if necessary, and the engine made to run either over or under.

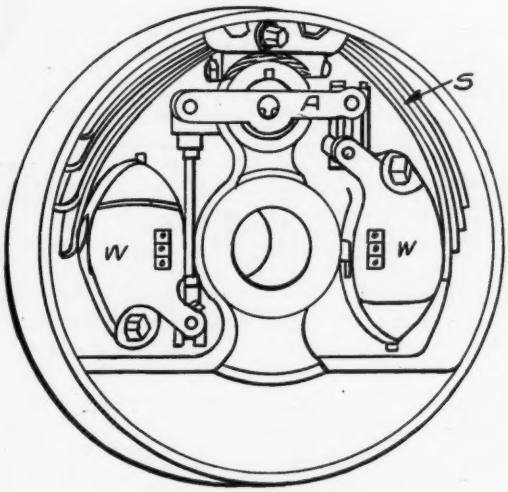


FIG. 12. RICE GOVERNOR

In the American-Ball governor, Fig. 15, 2 features attract attention; the method of establishing a gravity balance, and the arrangement and relation of the springs.

Besides the single pivoted arm, a second arm is so pivoted that its center of gravity is practically on the axis of the shaft, and, therefore, develops no centrifugal force. This second arm is so connected to the governing or centrifugal arm that the gravity of one is always opposed by the gravity of the other at every position of the wheel. Hence the centrifugal force of the governing arm under the control of the springs is made to govern the engine, while the disturbing gravitation of this arm is neutralized or balanced by the opposing gravity of the second arm, which, as before stated, has practically no centrifugal force.

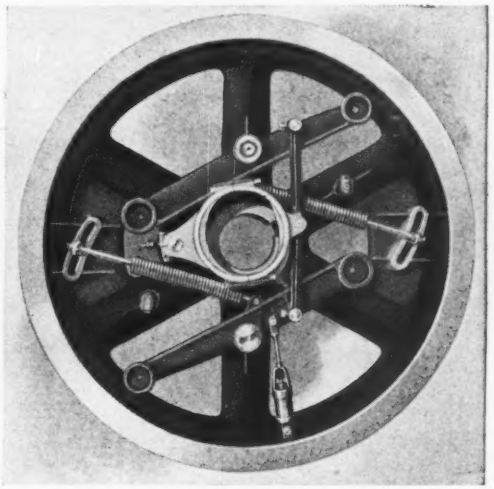

FIG. 13. HARRISBURG ENGINE GOVERNOR

Use of double springs prevents swaying or bellying and aids in the delicate balancing of the governing forces. These springs are convenient, also, for slight adjustments of what is known as the "characteristic" of the governor; or, in other words, the real difference in speed at the several points of cutoff. Generally speaking, and within limits, the slacking of the radial spring and the tightening of the other reduces the drop in speed under load, and the reverse adjustment increases it, which is often convenient where several engines are to be adjusted to run in parallel service and it is desired to make each take its share of the load.

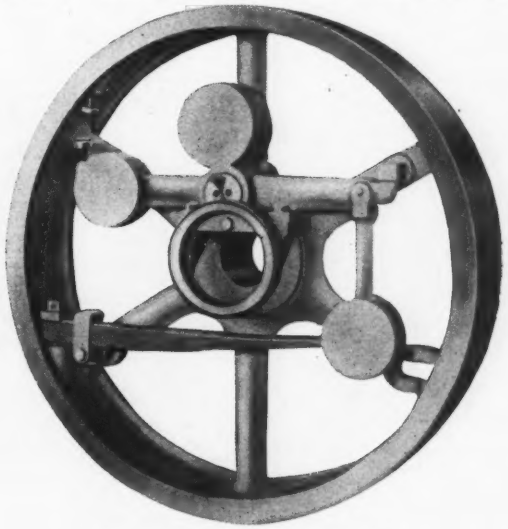

FIG. 14. ERIE CITY GOVERNOR

Figure 16 represents a Rites governor, manufactured under the Rites-Carpenter patents, and used on the Chandler and Taylor automatic cutoff steam engines. The Rites governor embodies both the centrifugal and inertia features by using a single weighted arm. The

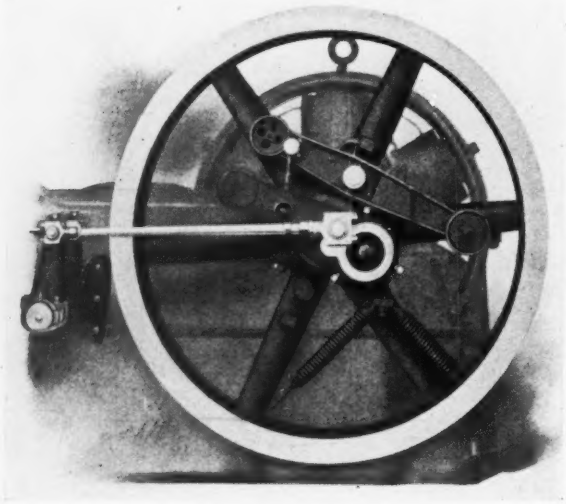

FIG. 15. AMERICAN BALL GOVERNOR

eccentric to which the valve is connected is part of the governor arm near its center, the motion of the governor arm being such as to shift the eccentric across the shaft and vary its angular advance. The governor weight in this design does not overhang the bearing pin, but is supported on both sides, the pin supporting the inertia bar being large and oiled by a compression grease cup through numerous corrugations in the pin.

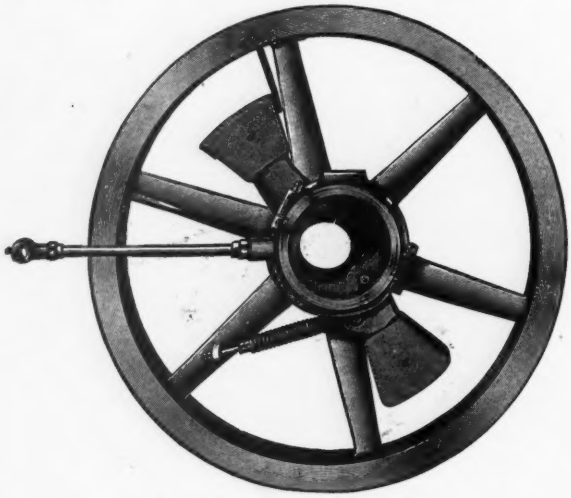

FIG. 16. RITES GOVERNOR

A form of Rites governor used on the Ames engine is shown in Fig. 17. It consists of a weighted arm suspended upon a stud on the arms of the flywheel, the inertia of the weight and its arm being counteracted by a spiral spring. The valve rod is attached to a pin on the inertia arm, which pin moves in an arc of a circle, the stud on which the governor is mounted, being the center. The motion of the pin being in an arc of the circle, both the eccentricity and angle of advance are varied.

The action of the Rites governor depends upon the inertia of the weights, although a certain amount of

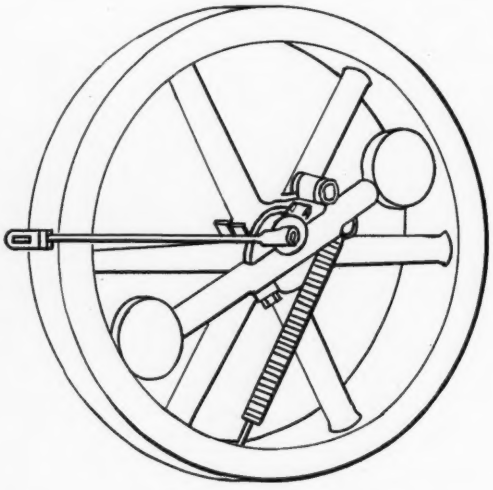

FIG. 17. MODIFIED RITES GOVERNOR USED ON AMES ENGINE

centrifugal force is indispensable. The action of this type of governor is as follows: If the load on the engine is decreased, the wheel will tend to jump ahead, while the heavy bar will, due to its inertia, lag back and act in harmony with the centrifugal force, thus adjusting

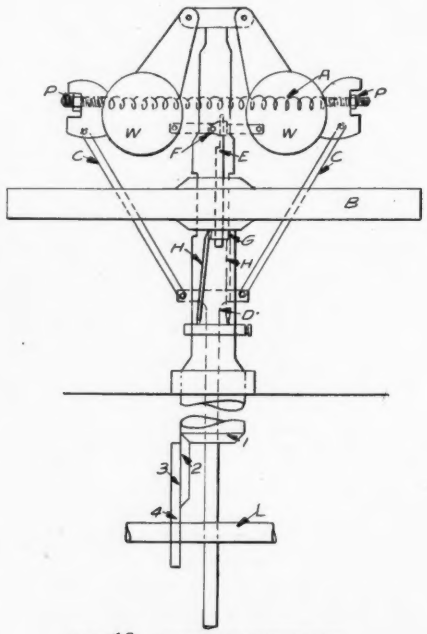


FIG. 18. BEGTRUP GOVERNOR

the valve to an earlier cutoff. If the load suddenly increases, the wheel will tend to slow down, while the heavy bar will tend to continue at the same velocity, acting with the decreased centrifugal force to shift the eccentric to a later point of cutoff.

In Fig. 18 is shown the Begtrup governor, which is used on the Greene-Wheelock engine, and, while it is a type of flyball governor, yet it embodies both the centrifugal and inertia features. The centrifugal force operating upon the weights, W, W, is opposed by coil spring A, which passes through the weights, the latter being slotted for this purpose. Weights W, W are connected to the governor spindle, D, through the connecting rods, C, C. The inertia weight, B, is in the form of a wheel, and is connected to the weights by means of the pin, E, which passes through the hub of the inertia wheel and the strap and toggle joint, F. These connections are made to both weights in the same way, but on opposite sides, although only one connection is shown in the sketch. The inertia wheel is loose on the governor body, G, and is supported by the spindles, H, H, but since it is connected to the weights it must rotate with them.

The governor is driven from the eccentric shaft, L, through gears 1, 2, 3 and 4 in the ratio of 2 to 1. The action of the governor is as follows: As the speed is increased, weights W, W are thrown outward by the centrifugal force, raising the governor spindle, through connecting rods C, C, thus giving an earlier cutoff. The tendency of the weights to move outward is resisted to a certain extent by the inertia wheel, which tends to revolve at its original speed. As the weights tend to return to their inner position, due to any decrease in speed, they are again resisted, to a certain extent, by the inertia wheel in the same way; that is, the wheel, due to inertia, tends to rotate at a certain speed regardless of the changes in the speed of weights, and its resistance to the weights prevents too sudden changes from one extreme position to the other. If the rotation of the engine is reversed, the eccentric shaft must turn in the opposite direction and, also the governor. This is provided for by changing the straps, F, to the opposite weights. The speed of the engine may be changed by changing the tension on spring A through nuts P, P. This is a very sensitive governor and gives close regulation.

# Is the Foundation to Blame

EXPERIENCES THAT PROVE THAT PROPER BALANCE IS ESSENTIAL FOR GOOD RUNNING. BY EUSTIS H. THOMPSON

MANY of us have seen a good machine placed on a foundation of doubtful quality, and bad operation result. How often does the fault finally appear in some unexpected quarter? Not only that, but occasionally the motor-generator set, or whatever it is, develops serious injury before the trouble is remedied, and a "shut-down" may occur and cause serious loss to the purchaser.

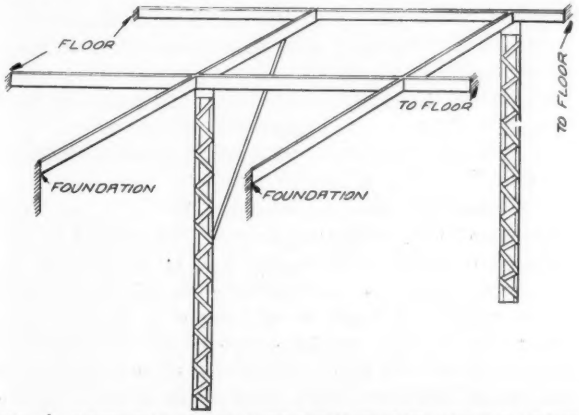


FIG. 1. UNUSUAL FOUNDATION FRAMEWORK FOR BALANCER SET

The writer's experience indicates that any foundation sufficiently strong to hold the set in proper alinement, without variation, may be utilized for ordinary commercial types of rotary sets, regardless of rigidity. However, when the rigidity is poor, the great refinements in line-up and balance, that are necessary to make good operation, involve a considerable expense. Deterioration is more rapid on a poor foundation.

In order to get the best results, practically and commercially, a good machine deserves a good foundation and a poorly operating machine absolutely requires one.

A good foundation is one that is not only strong enough at all points, but one that is so proportioned that it will not readily vibrate in synchronism with the machine.

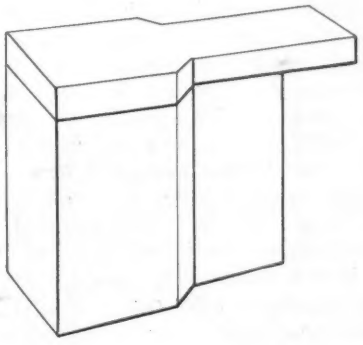

FIG. 2. FOUNDATION WITH EXTENDED CAP FOR FREQUENCY CHANGER SET

The following cases from "real life" illustrate some phases of the question:

A certain plant, when put in operation, contained a balancer set, of the 2-motor-in-series type, of about 60 kw. This was the prettiest plant ever visited by the writer, with water adjoining 3 sides, and was contained in a building of white stone, with a slate roof. It was one of a group of buildings put up by Uncle Sam with

the object of being decorative as well as useful, and judging from current report, that purpose was well fulfilled.

Shortly after being placed in operation, a bad vibration developed in this set. As the steel foundation was most unusual, consisting of a steel frame supported by 2 steel posts placed at diagonal corners, as illustrated in the sketch, the blame was tentatively placed on the foundation.

An "inspection party," consisting of official representatives of all those concerned, placed some temporary timbers under the set, and jacked up, but without improvement. The set was then examined, and the coupling found to be eccentric. This was corrected, the set balanced somewhat, and while the resultant operation was not perfect, it was near enough so as to be satisfactory and has continued thus for several years on the original foundation.

Now, why was that foundation sufficient? It is probable that the answer lies with the balancer set. Being a square set of 2 bearings and light torque, the bed plate was sufficiently rigid in itself, to maintain a good enough alinement, regardless of springing in the supporting element.

A different instance was that of a 500-kw. turbo-generator set. The turbine end rested on a solid concrete foundation, while the generator end was supported by the steel-concrete floor of the power house. The old engineer who scents trouble from this description is certainly justified. A solid concrete foundation represents the last word in rigidity, while a floor is subject to changes in elevation, due to temperature, and is extremely "unrigid" when it comes to resisting vibration or torque.

Naturally vibration spells developed. These were quelled by placing temporary braces under the generator.

Finally, the original foundation was extended so that the set was given a solid support, and its operation has been practically perfect ever since.

A frequency changer set of about 1000 kw. supplied most of the power for a continuous process manufacturing plant. After being placed in service, a vibration developed that became worse and worse. A shut-down of this set would seriously cripple the plant, and the loss would amount to many thousands of dollars an hour, and might even include the loss of a section of trench by the Allies.

The foundation consisted of a solid block of concrete, extended at one end by placing a cap of reinforced concrete on top, so as to be long enough to support the bed plate of the set. An engine set, which had been placed on the original block, had given no end of trouble. The frequency changer set had given good operation at another plant, so it is not hard to see why the foundation appeared responsible for this trouble.

As it happened, the crisis came on a Saturday night, when the set could most easily be spared from service. The vibration became so intense that the foundation was hastily examined for cracks, but none were found. A few minutes later the coupling bolts "let go" and a speedy shut-down was accomplished, preventing further damage.

The alinement at the coupling was first inspected, and found to be very bad. The bearings and armature were then placed in careful alinement by a little overtime work, so that the set was ready for operation the following Monday. Operation was greatly improved, but still far from good. As soon as an opportunity presented itself, the set was drilled and tapped and carefully balanced. The operation was then practically perfect, and has continued to be very good.

The set had been only in fair balance when installed, and the ends of the bed plate had been wedged up too high, when the set was installed, throwing the bearings out of line. The foundation, which at first sight appeared guilty, received a verdict of innocence.

### Trouble on Battleship

An extreme of "unrigidity" was reached on a certain battleship, or, to be more, accurate, a "superdreadnaught," which was the mightiest in the world when commissioned by Uncle Sam. Four turbo-generator units, of 300 kw., were installed, 2 forward and 2 aft. These supplied power for practically everything on the ship except propulsion. Steering, cooking, hoisting ammunition, turret control, blowers, gyro-compass, etc., all derived power from this relatively small plant. These sets were known to have operated very well in the factory, but aboard ship it was a different story.

The support for these sets consisted of a deck of ¼-in. steel laid over light I-beams. Needless to say, the slightest vibration set up in the turbines was communicated to the deck, and often greatly magnified. To counteract this, stanchions were installed between this deck and the double bottom of the ship, 10 ft. below, at points where they would do the most good. This, however, did not appreciably help matters. The reason was that the double bottom of the ship consisted of comparatively thin steel plates and thin vertical gussets, and there was no weight available to tie to, so as to dampen vibration. The stanchions vibrated themselves easily.

The worst operating of these sets communicated vibration even to the upperdeck of the ship. This had not been run very much, when the binding wire "let go," causing a partial wreck.

A spare armature was located in the Navy Yard and loaded with a floating derrick. The ship left port that night, on her first voyage, and by next night, the new armature was in place and the set had been brought up to speed. It might be of interest to mention that the writer made a careful search of the windings and discovered a knife blade, pretty well chewed up. Later on, one of the crew found some pieces of knife handle. The mystery of the binding wire was argued as per Doyle and Watson. It appeared that since the blade did not belong to a regulation Navy knife, the blame was placed on some men who had been cleaning the sets, before they were turned over to the Government. The knife had been left in the field and remained there until jarred loose, causing the binding wire to come off. This little detective work was of no small advantage to the makers of the machines, who would otherwise have been responsible, as the sets had been installed and cleaned by a third party.

When the above mentioned set was put in operation, the vibration was very bad. In order to make it satisfactory, the line up was checked, and refined as much as possible. Both turbine and armature were carefully re-balanced, and practically perfect operation resulted. This set was considered by those in a position to know, to be the best running one of its kind in the Navy. The interesting part was that after the minutest vibration had been refined out of the set, there was none noticeable in the sensitive steel deck on which it rested. All of these sets would have operated well on a concrete foundation in the first place.

The other 3 sets, which previously had been considered acceptable, now appeared in a less favorable light, by comparison, and it was then decided to refine them in alinement and balance.

Our work on the remaining sets proved easier than expected, and was completed just in time to avoid a tropical cruise on the ship. Temperatures in New York Harbor were not comfortable, and engine room work in the tropics is more pleasant to imagine than to experience.

# Notes on Oil Fuel

LETTERS sent out to the Standard Oil Co. and various users of fuel oil for power plants, mostly in the West, by a committee of the National District Heating Assn. on station operation, brought the information which is summarized as follows:

High price of fuel oil and fluctuations in price are such as to make it inadvisable to install oil-burning plants in any region where cheap coal can be had. In a plant on the Pacific coast with a load of 10,500 kw., the records show 200 kw.-hr. per barrel of oil with a load factor of 0.4, 24 hr. service and railway load. Even in the West, when a plant is installed, provision is made for future installation of coal burning furnaces if that should become desirable.

Almost any kind of a nozzle that will divide the oil finely by means of a vapor under pressure will work well, and the ordinary form of boiler setting is suitable,

COMPARISON OF COST OF COAL AND OIL FOR FUEL

| | Coal | | | | | | Oil |
|---|---|---|---|---|---|---|---|
| B.t.u. per lb..... | 10,000 | 11,00 | 12,00 | 13,000 | 14,000 | 15,000 | 18,500 |
| Boiler efficiency.... | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| Evaporat'n from and at 212 deg. F..... | 6.18 | 7.15 | 8.17 | 9.25 | 10.4 | 11.6 | 14.88 |
| Lbs. per boiler hp... | 5.58 | 4.82 | 4.22 | 3.73 | 3.32 | 2.97 | 2.32 |
| Lbs. coal equivalent to 1 bbl. oil..... | 808 | 698 | 611 | 540 | 481 | 431 | .... |
| Bbls. oil equivalent to 1 short ton coal | 2.47 | 2.86 | 3.27 | 3.70 | 4.16 | 4.64 | .... |
| Bbls. oil equivalent to 1 long ton coal | 2.77 | 3.20 | 3.67 | 4.15 | 4.65 | 5.20 | .... |
| Price of 1 short ton equivalent to oil at 70c per bbl..... | 1.74 | 2.00 | 2.28 | 2.59 | 2.91 | 3.24 | .... |
| Price of 1 long ton equivalent to oil at 70c per bbl..... | 1.94 | 2.24 | 2.56 | 2.90 | 3.25 | 3.64 | .... |

with the nozzles sometimes located in the back, and sometimes in the front. Boilers with vertical baffles will usually have larger and better combustion space when fired with a back shot burner; also in the B. & W. and Stirling boilers the back shot type of burner will permit forcing the boiler to a higher rating than will the front shot.

Heat value of the Bakersfield oil, largely used in California, is about 18,600 B.t.u. per lb. For burning this in the plants of the Pacific Gas & Electric Co. the grates are covered with fire brick with spaces left so that the air can enter directly under the flame. Oil on reaching the fire room is heated to 180 deg. F. (80 deg. C.) and is delivered to the burner under a pressure of 50 lb. While air may be used for atomizing, the amount of steam required is so small as to make the use of an air compressor unprofitable. Steam used may run to 3 per cent of that made, but it is possible by care to reduce this to 1 per cent. Three to 4 burners are used for a boiler up to 800 hp. capacity. For boilers with the horizontal baffles, the front shot burner, with the nozzle near the fire doors and sending the flame towards the rear is found desirable.

Higher boiler efficiency can be obtained with oil than with coal the same as better efficiency can be secured with high grade coal than with poor. The table herewith shows the comparison of coal and oil fuel costs with oil at 70 cents a barrel. The higher efficiency with the oil comes from the fact that the oil can be burned with a less excess of air than can the coal. Oil has another advantage in that the fire is never banked, so that there are no standby losses. When the fire is not needed it is put out, and can be started up again in 30 sec. and the boiler be ready for steaming in 30 min. There is also a saving in fire room labor, as one man can fire 6 or 8 large boilers totaling 5000 hp. The stacks do not have to be so high nor so large as for a coal fired plant, and no forced draft equipment is necessary; but it is usual to design the setting and arrangement of the plant so that rebuilding for coal is possible in case the price of oil should rise so as to make coal the desirable fuel.

When boilers must be maintained in condition to cut in at any time, it is customary to put out the fire, close the damper tight and let the boiler stand until the pressure has dropped 20 to 30 lb., when the fire is started and the pressure raised again. The damper must close tight, however, as leakage of air will quickly cool off the boiler and setting. This points to a possible use of oil fuel for maintaining standby boilers even in plants where the use of coal for carrying the load is more economical, as the oil used is only 1.5 per cent of that needed to operate to full capacity.

## Anthracite Coal in 1915

REPORT OF the Department of the Interior, U. S. Geological Survey, on this subject shows that during 1915 approximately 79,500,000 gross tons were produced as against 81,000,000 in 1914, a decrease of 1,500,000 tons. The average value at the mines, $2.32, was practically the same for both years.

There is an increased tendency for the smaller sizes such as pea coal and, to some extent, buckwheat, to be used in the domestic trade, thus tending to cut down the amount available for steam supply. The prepared sizes larger than pea, which amount to some 52 per cent of the total output, are used for domestic purposes principally.

The indication would seem to be that, even in the eastern part of the country, more and more anthracite will disappear as a power plant fuel, and provision must be made to burn satisfactorily a bituminous fuel.

# Advantages of a Uniform Boiler Inspection Code*

How a Uniformity of Rules Would Improve the Standards of Inspection. By T. E. Durban

RUNNING parallel with the advantages of a Uniform Code for the construction of boilers are the advantages of a Uniform Boiler Inspection Code. A uniform code for construction without proper uniform inspection is very liable to fail utterly in its purpose. If you have as many modes of inspection and as many interpretations of the Code as you have inspectors and inspection companies, the Code itself would become so distorted as to destroy absolutely its value.

In general the primary or fundamental basis of boiler laws should start with the construction of the boiler itself, and the specification of material for the construction. We believe that the American Society of Mechanical Engineers in presenting to the American public its boiler code has taken the first step necessary to put the boiler manufacturer and the boiler user in a proper position before the American public. The next step in line is the proper inspection. If the boiler is not properly inspected during the process of construction and made right in the shop, it can never be right in the field, as it is apparent that without a rigid inspection to see that the boiler comes up to the Code in the minutest detail, the Code itself is rendered valueless. A rigid and proper code of inspection would remove any possibility of commercialism.

Politics and commercialism are two things to be avoided above everything else in the inspection of boilers, and yet to overcome this is almost like trying to make over human nature. But a standard Code under which all inspectors must be compelled to operate would certainly eliminate to a large degree the commercial feature.

If a liability company has a client that is a large and profitable one, his tendency would be to favor him as much as possible under any law or under any code, and a rigid code of inspection enacted by law would often relieve liability companies from very embarrassing positions. We all have in our experiences had cases of this kind, and being human we do the best we can to protect our business interests. If there were a common law, however, governing the inspection and the mode of inspection, and requiring a rigid examination of those men who are elevated to the position of inspectors, it would be a relief to everybody concerned, and would be a great step forward in the protection of life and property.

All manufacturers of boilers who have inspection done at the shop and the boiler properly stamped, have had questions raised by the state inspector or inspectors in the field, bringing embarrassment to the inspector, to the shop, and to the customer. Frequently this difference of opinion would be in a minute detail, and would be the opinion of the inspector or his individual interpretation of the specifications, and would in no way affect the safety of the boiler. A Uniform Inspection Code would tend to eliminate many of these problems and releive many vexatious situations.

*From a paper read before the First Ohio Boiler Inspectors' Convention.

To make a Uniform Inspection Code effective, one code or standard of construction should be used, in order to avoid a multiplicity of constructions that could be placed on the interpretation of different specifications as they are drawn.

In my experience, covering some 30 yr., I have yet to see a detailed specification on a water tube boiler, and I have been unable to decide in my own mind whether this is because the engineers and insurance companies and people who are in the habit of drawing specifications concede that water tube boilers are better constructed and need less of the details stated in the specifications than boilers of other types, or because they have more confidence in builders of water tube boilers, and yet many makers build both water tube and fire tube boilers.

With the specifications now issued by the American Society of Mechanical Engineers, it seems that boilers specified of a certain horsepower or a size to correspond to the American Society of Mechanical Engineers Code would be all that was necessary, and if the particular engineer who drows the specifications has his specific manner of equipping or specific fittings that he wishes to put on the boiler owing to former good results from these fittings, to include these in the specifications, but in the construction of the boiler proper let it go according to some standard uniform construction without going into the details of construction and thus possibly confusing the inspector in his work.

Every inspector, no matter by whom he is employed, should inspect according to the letter of the law, and "good enough work" and "safe enough work" should not be passed, and no boiler should be stamped with the emblem of the Society or State or liability or insurance company that does not in every way correspond to the specifications under which it is built, and we believe that this is the intention of everybody connected with the art, but unfortunately in many respects our good intentions are never carried out.

What the manufacturer and the user wants is uniformity throughout. All manufacturers are anxious to have their product good and acceptable. On the other hand, they are equally anxious to know that they will not be handicapped by inspection, and that if they are required to live up to certain standard, they want to be sure that their competitors are compelled to live up to that same standard.

We know of cases where the strongest kind of political pressure has been brought to bear on the inspection department of a state in order to compel them to accept certain boilers at a given pressure when they had ordered the pressures reduced. So that the abuses in inspection are just as apt to come from state inspectors from pressure that is brought to bear on them as it is from inspectors of liability companies who are brought into severe commercial competition in protecting the interests of their company, both as to the risk involved and as to the company's position in the business world or volume of business which the company may do.

The inspector should see that the boiler comes up to the letter of the law in every detail, regardless of the interests that direct his efforts, and his first thought at all times should be the protection of human life and property.

# Electrical Machinery and Appliances

*For Generating, Transmitting and Using Current*

# Adapting D. C. Motors to Changed Conditions

DISCUSSION OF THEORY OF MACHINES AND METHOD OF OPERATION OF VARIOUS SPEEDS AND VOLTAGES; OPERATION OF MOTOR AS GENERATOR. BY H. L. SMITH

IT IS frequently desirable to change a direct-current motor so that it may be operated under different conditions, for instance, at a speed other than the rated one, at a different voltage, or which changes in its characteristics, such as regulation, etc. The problem of operating a motor as a generator also presents itself. Many of these changes may be made in the field with little trouble and expense. The general theory encountered in considering the usual changes is relatively simple.

First consider some fundamental principles in the operation of a direct-current generator. The field poles supply a stationary magnetic field, which is cut by the

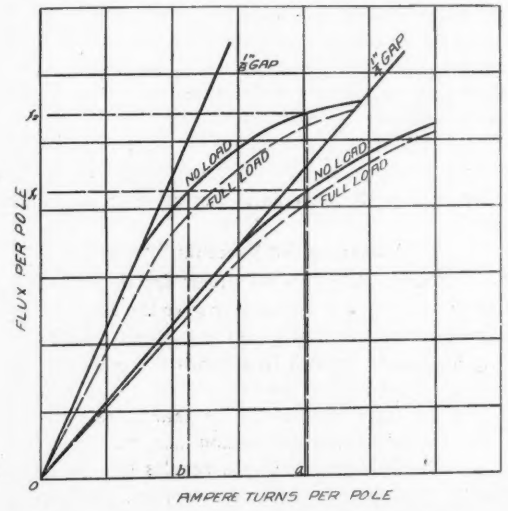


FIG. 1. TYPICAL MAGNETIZATION CURVES

conductors on the revolving armature, and causes an electromotive force to be generated in them, which is directly proportional to the magnetic flux and the rate of cutting. This electromotive force causes a current to flow through the armature and the external circuit. Whenever a current flows through a conductor in a magnetic field, a force is exerted tending to move it to one side or the other, depending upon the direction in which the current is flowing, relative to the flux. This force is directly proportional to the flux and the current flowing. When conductors in the slots of an armature are acted upon by such a force, a turning moment or torque is produced. In a generator the current flows in the same direction as the electromotive force generated by the armature. Due to this direction of flow, a torque is produced which opposes rotation; thus external power is required to drive the armature and overcome this force. Since the current flows in the same direction as the generator electromotive force, the internal resistance drop opposes the flow, thus the terminal electromotive force is equal to the generated electromotive force minus the resistance drop. In the case of a motor the line electromotive force drives the current through the armature, and thus a torque is produced which causes rotation. As soon as the armature rotates, an electromotive force is generated in the same way as that produced in a generator. In this case the electromotive force opposes the flow of current. Stability is reached when the difference between the generated voltage or counter electromotive force and the applied electromotive force is just sufficient to allow a current which will produce the required torque to flow through the internal resistance. In other words, internal resistance drop plus the counter electromotive force always equals the applied electromotive force. The following equations show the above very clearly:

$$\text{In a generator, } E = \frac{Ws\ p\ f\ Rm}{60 \times 10^8} - IR_1 \quad \ldots\ldots (1)$$

$$\text{In a motor, } Rm = \frac{(E - IR_1)\ 10^8 \times 60}{Ws\ p\ f} \quad \ldots\ldots (2)$$

Where E is the terminal electromotive force; I, armature current; $R_1$, resistance of armature, commutating and series coils; Ws, series conductors on the armature; p, number of poles; f, magnetic flux issuing from one pole, in kilo-lines per sq. in.; Rm, R.p.m.

The function of the field coils, both the shunt and series, is to supply the magnetizing force necessary to produce the required flux. This magnetizing force is directly proportional to the combined ampere-turns of the exciting coils, which are determined by the current flowing in one turn, multiplied by the number of turns in the coil. The result is the same whether it be a small current and a large number of turns, or vice versa. The magnetizing force is made up of 2 parts, by far the larger being that required to drive the flux across the air-gap. This part varies directly as the flux and the equivalent air-gap length; being a direct fun-

tion, it is plotted as a straight line, as shown for 2 different lengths of air-gap in Fig. 1. The magnetizing force for the iron part of the circuit follows no direct law, but depends on the magnetic density and material. It is represented in Fig. 1 as added to the air-gap line, giving the solid curved line, or the no-load saturation curve. When operating under load, the armature teeth and pole tips become more or less saturated, due to armature reaction, and the flux is slightly reduced. To get a general idea of the effect of changing the air-gap on the flux and excitation consider the relation expressed in Fig. 1. With a ¼-in. air-gap a magnetizing force of *oa* ampere turns will be required to produce the flux $f_1$, while with a ⅛-in. gap, only *ob* ampere turns will be needed to produce the same flux. Again, keeping the excitation constant and equal to *oa* ampere turns, a ⅛-in. air-gap will give a flux equal to $f_2$.

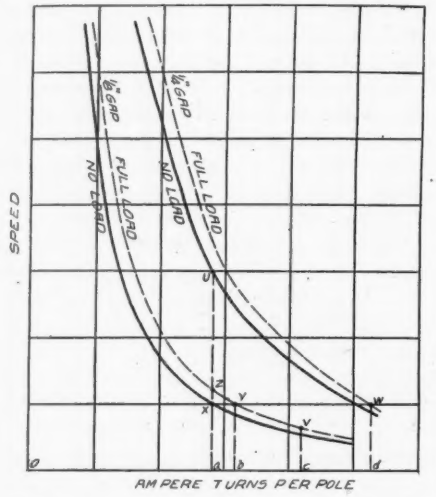


FIG. 2. TYPICAL SHUNT REGULATION CURVES

From the equation of a given motor operating at any given load the flux for any given field excitation can be reduced to speed, and plotted as such against field ampere turns. This gives the curves in Fig. 2, which are better adapted for showing the relations of speed and regulation. These curves may readily be taken by test, and are known as the shunt regulation curves. From the equation one would naturally expect the full-load curve to fall below the no-load. It may or may not, depending upon the relation between the resistance drop in the motor and the reduction in the flux due to armature reaction. Usually the full-load curve is the higher, as in Fig. 2, except in high voltage, or small size machines, where it may coincide or fall lower.

By inspection of Fig. 2 it will be obvious that the speed can be changed by varying the field excitation, or by changing the air-gap length, or both. In practice the field excitation may be reduced by adding resistance in the shunt-field circuit, but can only be increased by using new shunt coils, or by increasing the electromotive force impressed upon them. In most modern machines, which are built with the poles bolted to the frame, a considerable adjustment in the air-gap is possible. The poles are made short enough, so that by inserting sheet steel liners next to the frame, different air-gap lengths can be obtained in small steps over a considerable range. According to Fig. 2, one might think that the speed could be increased to the desired point by shunt resistance alone. The desired speed certainly could be obtained, but speed regulation would probably be bad, the machine more or less unstable, and the hot and cold speeds would vary greatly. It is true that certain adjustable speed motors will operate satisfactorily over the wide ranges of speed. As high as 4 to 1 speed ratios are commonly obtained by shunt field control, but in the design of these motors special attention is given to the regulation at high speeds. A constant speed motor having practically a flat speed curve at its rated speed may have a decidedly rising characteristic on weak field, thus it is hardly safe to depend on this method.

It is not always possible to distinguish a compound from a shunt motor by its series coils, for it is the practice of some manufacturers to supply series coils on the shunt machines also, except in the case of small sizes and high voltage machines. The function of the series coil on a shunt motor is to insure stability and give a more nearly flat speed curve. In Fig. 2 oa represents the ampere turns supplied by the shunt coil. At no-load the speed will be x. If there is no series coil, the full-load speed will be equal to z. Plotting these values as speed curves, as in Fig. 3, it is found that the speed actually rises with the load. This is objectionable, and tends to produce an unstable condition. Now if a series coil be added which will supply ab ampere turns there is a total of ob ampere turns acting on the pole, which will give a speed at full-load equal to y, which is also equal to x; thus we have a flat speed curve xy in Fig. 3, which is desirable for a shunt motor. By using a series coil which will supply ac-ampere turns, a full-load speed equal to v is obtained. This gives a drooping characteristic, xv in Fig. 3, such as is desirable in a compound motor.

### Operation at Various Speeds

No definite rule can be given for determining the change in an air-gap necessary to give the required speed. It may be roughly stated that the per cent change in the air-gap should be from 3 to 4 times the per cent change in speed. This should be considered as only approximate, for accurate results can be calculated only with a full knowledge of the saturation curves. However, in most cases sufficiently accurate results can be obtained, unless the machine in question is worked high up on the saturation curve where the iron is practically saturated, or very low on the curve, where the excitation is nearly all used in the air-gap. It is usually possible to change a speed from 10 to 15 per cent by manipulation of the air-gap alone where the iron is not highly saturated. Of course, there are exceptions. In some cases, no change at all is possible in the desired direction; in others, a much greater change than stated can be obtained, all depending upon the length of air-gap in the machine. When a higher speed than can be obtained by increasing the gap alone is desired, it may be permissible to add such a resistance to the shunt circuit as will give the right speed. In this case, the regulation should be checked carefully and possibly adjusted as explained below.

### Adjustment of Regulation

For certain classes of work, such as a line shaft, practically constant speed is required from no-load to full-load. A shunt motor should be used to drive this type of load. Other classes require drooping speed characteristics, varying from the standard 20 per cent regulation, to the heavily compounded bending roll motors, which have only enough shunt ampere turns to keep them from running away at no load.

Referring again to Fig. 2, it is obvious that if there are oa ampere turns at no-load, and ob ampere turns at full-load and a ⅛-in. air-gap, the speed curve will be flat, as xy in Fig. 3. Changing the air-gap to ¼-in. gives a no-load speed equal to u. By adding series turns until the full-load ampere turns equal od, a speed w will be obtained, which is the same as that obtained at full load with the smaller gap. This condition gives speed curve uy in Fig. 3, which is a compound characteristic.

From the preceding, it is obvious that to obtain a compound characteristic from a shunt motor the air-gap should be increased, then series turns added until the full-load speed is the same as it was before. Flexible copper cable wound over the shunt coil, and tied in place, makes a good series coil. It is easily wound, and requires no extra insulation. The copper section should be about the same as that of the old coils, so as to insure no overheating. When changing from a compound to a shunt characteristic a smaller gap should be used, and then current shunted out of the series coil until flat speed curves are obtained.

### Operation at Other Voltages

There are 3 common voltages used on direct-current circuits 115, 230 and 550 v. The question may arise how to change the motor built for one voltage so as to operate on either one of the others. A 230-v. motor may have its shunt coils connected in 2 groups and parallel, then connected across a 115-v. circuit. In this case the voltage per coil has not been changed, thus the flux will remain constant, but the speed will only be half what it was before. This can be brought up to the normal again by using the maximum air-gap and reducing the shunt field by resistance. When operating a 115-v. motor on a 230-v. circuit the minimum gap should be used and the shunt coil worked at the maximum temperature. This probably will not bring the speed down to the rated one, but it is the best that can be done without new coils. The same procedure follows when changing from one circuit to another. When going to a higher voltage use the minimum air-gap and shunt field resistance, but working the coils as hard as possible. When going to a lower voltage use the maximum gap and parallel the coils.

So far no change to the armature has been contemplated. It is evident that the current in the armature conductors should be left the same regardless of impressed voltage, so as to insure safe temperatures. An exception to this is at low speed where the ventilation is poorer, when the current may have to be slightly reduced. Since the horsepower output varies as the voltage, current and efficiency, it follows that for the same armature current the output will vary as the impressed voltage. This means that if a 115-v. motor be operated on a 230-v. circuit the horsepower will be doubled, although the speed has been kept nearly the same. The reverse is also true of a 230-v. motor on a 115-v. circuit.

### Speed Reduction by Means of Resistance in the Armature Circuit

Equation (2) shows that the speed still depends on 3 terms: $(E - IR_1)$, Ws and p. The number of poles cannot be changed, and Ws is a function of the armature winding and not readily changed. The line voltage is also a constant. From the equation it is obvious that by increasing $R_1$ the speed at any load will be decreased, but that the no-load speed will remain the same. Since $R_1$ is internal resistance, or the resistance of the armature, commutating and series coils, it cannot be increased; but an external resistance $R_2$ can be connected in series, which has the same effect; thus the term becomes $E - I(R_1 + R_2)$. Since the speed varies as $E - IR$ or the counter electromotive force the ratio can be obtained as in equation (3):

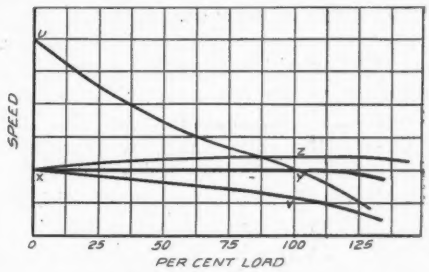


FIG. 3. TYPICAL SPEED CURVES

$$\frac{Rm_1}{Rm_2} = \frac{E - I_1 R_1}{E - I_2 (R_1 + R_2)} \quad \ldots\ldots\ldots (3)$$

$$\text{whence } R_2 = \frac{(Rm_1 - Rm_2)\, E + R_1 (I_1 Rm_2 - I_2 Rm_1)}{I_2 Rm_1} \quad (4)$$

Where $Rm_1$ is the present full-load speed; $Rm_2$ desired full-load speed; $R_2$, necessary resistance to be put in the armature circuit; $I_1$, armature amperes at full load; $I_2$, armature amperes at desired load.

Equation (4) gives an expression for determining the amount of external resistance, to be added to the armature circuit to give a desired speed reduction. Besides poor regulation, there is a considerable loss in the external resistance, which lowers the efficiency. In spite of these drawbacks it is often profitable to use this method of speed reduction where the load is practically constant and the low speed is only needed at intervals. The driving of blowers and centrifugal pumps comes under this head. With this class of service the power required decreases so fast with the reduction in speed that a comparatively small resistance is needed. About the only requirement for this external resistance is to be able to radiate the heat generated without excessive temperatures.

Using external armature resistance is merely a method of reducing the impressed voltage over the armature, by using up part of the line voltage in the resistance. Thus the mechanical horsepower output will be

reduced in proportion to the reduction in armature voltage or to the reduction in speed, since they are proportional.

### Operation of Motor as a Generator

It is usually an easy matter to operate a generator as a motor, but when the attempt is made to operate a motor as a generator trouble is encountered in obtaining the required voltage at full load. This is not a fault of the machine, but is an inherent quality in the design. In the case of a generator the line electromotive force is equal to the electromotive force generated by the armature minus the resistance drop, while in a motor the line electromotive force equals the armature electromotive force plus the resistance drop. According to this, one would expect the terminal voltage at full load, of the motor operating as a generator, to be lower than the rated motor voltage by twice the resistance drop, assuming the speed, armature current and flux as remaining the same. The flux will not remain constant on account of the reduction of the voltage over the shunt coil, so that the terminal electromotive force will fall still lower. In order to raise this voltage the first thing to do is to obtain the minimum air-gap; the speed at full load should then be noted running as a motor with the series coils cut out. The following equation will then determine the speed at which it will be necessary to operate, so as to obtain the desired voltage at full load, running as a shunt generator. It is well to increase this speed slightly so as to have some latitude for overloads.

$$Rm_2 = Rm_1 \frac{(E_2 + IR_1)}{(E_1 - IR_1)} \quad \ldots\ldots\ldots\ldots\ldots (5)$$

Where $Rm_2$ is the speed when operating as a generator; $Rm_1$, the speed when operating as a motor with the series field cut out; $E_2$, terminal voltage at full load, operating as a generator; $E_1$, line voltage as a motor; I, armature current; $R_1$, internal resistance.

When operating as a compound generator the series coils should be adjusted so as to give the required compounding.

The changes as just considered apply to cases where the generator voltage is to be equal to or higher than the voltage as a motor; for instance, a 115-v. motor operating as a 125-v. generator, or a 230-v. motor as a 250-v. generator. Equation (5) is based on the assumption that the shunt excitation remains the same. This will only be true when a shuntfield rheostat is used. Since it is not necessary that the shunt excitation be increased beyond what it was as a motor, the temperatures should not change. When it is wished to operate a 230-v. motor as a 125-v. generator it is usually sufficient to keep the same speed and air-gap, for the flux will not decrease as fast as the shunt excitation, on account of saturation. The output as a generator will be equal to the ampere rating as a motor multiplied by the voltage rating as a generator.

It may thus be taken as a general rule that for successful operation of a motor as a generator the speed must be increased. In certain cases this may not be necessary, for the decrease in the air-gap may compensate for the difference. This should be no great drawback, however, for with belted machines the speed can be easily varied by use of different pulley ratios.

### Mechanical Limitations

When increasing the speed of any motor or generator great care should be exercised not to allow the speed to exceed the limit of safe operation. It is not merely a question of the band wires or wedges withstanding the stresses due to centrifugal force, but also the rigidity of the coils. The insulation is more or less plastic, and when under stress the coils will shift slightly, which will throw the armature out of balance. An armature designed for high speed will not only have heavier banding, but the coils will be braced by coil supports. At high overspeeds it is also found that the commutator bars will deflect a certain amount. This distortion will reduce the brush contact and cause bad commutation. Usually the factor of safety is so large that a 25 per cent increase in speed will be perfectly safe. Any greater increase should be taken up with the manufacturer.—The Electric Journal.

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# Picturing Electric Service to America's Millions

In the competition of The Society for Electrical Development, which closed June 1, over 800 posters were received, representing over $100,000 worth of designs.

The big idea was to get an official poster for America's Electrical Week which would most appropriately depict the influences of Electricity—and at the same time be a fitting design for this great national undertaking. The design had to be striking to get attention, and it had to be a design which could be faithfully reproduced in everything, from a poster stamp to a bill poster.

The judges were unanimous in their choice—which might well be entitled "Aladdin: Symbol of Service," yet the modern Aladdin, pictured in this poster, performs wonders that make the adventure of our Arabian Nights hero fade into insignificance.

Over 800 poster designs in colors were submitted and turned over to the judges, who, after many deliberations, determined the winners of all of the prizes except the Public Choice Prize.

The prize winners were then voted on with the following result:

The first prize of $1000—Harold von Schmidt, San Francisco, Cal.

The second prize of $500—John A. Bazant, Bronx, N. Y.

The Art Students' prize of $200—Edward Staloff, Jersey City, N. J.

The first school prize of $100—Harold H. Kolb, Sommerville, Mass.

The second school prize of $50—Wm. E. McKee, Jr., Hollywood, Cal.

The third school prize of $25—Armand Moreda, Brooklyn, N. Y.

The fourth school prize of $15—Ruth M. Jameson, Buffalo, N. Y.

The fifth school prize of $10—Edna E. Crowley, Chicago, Ill.

The Public Choice prize of $300 was awarded to the work of Vincent Aderente, of New York City.

# Some Electrical Repair Kinks

BANDING AN ARMATURE; REPAIRING A COMMUTATOR

ENGINEERS who at some time or other are required to reband motor or generator armatures may find it considerably difficult to make a satisfactory job. The various rows of wire will spread or the whole band will be loose, thus defeating its very purpose and rendering operation of the armature dangerous to the coils.

Small armatures are preferably banded in a lathe as shown in Fig. 1, while large ones may be allowed to remain in the machine as in Fig. 2. When employing the former method the armature is placed in the lathe and a length of strong rope, no more than ¼ in. in diameter having both ends looped, wound around as in Fig. 3, the end of the band wire being slipped through the overhanging loop and twisted about itself.

Proper tension in the band wire is obtained by placing the spool of wire in a rack made of a small box with 2 short strips of wood nailed to the sides to form supports and clamping the wire between the jaws of a carpenter's wood clamp tied to the floor by rope. As, therefore, the armature is caused to revolve, all tension is between the armature and the clamp with none on the spool.

A small weight tied to a short length of rope swung over the side of the spool and with opposite end nailed to the box acts as a brake and prevents the unwinding of the wire on the spool.

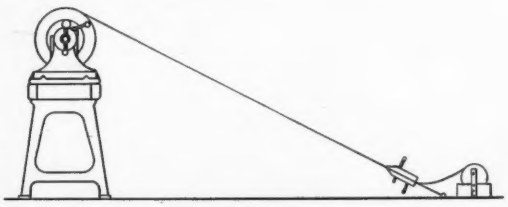

FIG. 1. METHOD OF HOLDING WIRE UNDER TENSION WHILE BANDING ARMATURE

As the wire is guided into place, place strips of sheet mica, having a width about ¼ in. greater than the finished band, under the first turn of wire with holding strips every 6 in. between the mica and the wire. These holding strips may be of tin approximately ¼ in. or more in width and with a length equal to ½ in. plus the width of the band.

After the first turn is completed and all mica and holding strips are in place, the shift gear of the lathe may be thrown in and the winding continued, the wire being guided by hand. It will be found, however, spite all precautions taken that as the winding progresses, the individual turns will spread, a condition easily remedied by stopping the lathe and forcing the turns together by means of a small flat drift and hammer.

With the band of required width, the lathe is stopped and the ends of the holding strip last passed, turned over. For a distance of about 2 in. on each side of this holding strip sprinkle a pinch of powdered rosin, after which solder this short section by going over it with a flat-faced soldering iron and, preferably, string solder.

The wire leading to the clamp may now be clipped at a distance of about ¼ in. from the last holding strip, the short end turned over as shown in Fig. 4 and securely soldered in place. In like manner cut, turn and solder the starting end, thus securely holding the band. Then after slowly turning the armature over and correcting any spreading of the individual turns as directed above, turn over the ends of all the holding clips and complete the soldering of the band, care being taken that the solder be only between the various turns of wire and none on top. This may be done by running over the completed band with the flat face of the soldering iron and removing all surplus solder.

Armatures too large for available lathes may, as stated above, be banded by removing the top half of

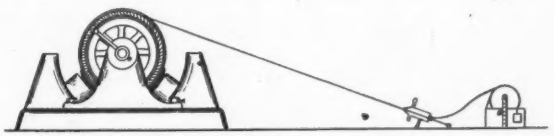

FIG. 2. A LARGE ARMATURE MAY AS READILY BE BANDED IN THE MACHINE AS IN THE LATHE

the field yoke and handling the work as though in a lathe, the armature being revolved by one or 2 men turning a crank attached to the end of the shaft as illustrated in Fig. 2. Care must, however, be taken not to allow the men to release the tension in the wire while building up the band.

If conditions so permit the armature may be driven by a small motor belted to a pulley on the armature shaft, and a wooden brake provided to stop the armature instantly if required.

## MAKING STRING SOLDER

IN MANY electrical repair jobs and especially when splicing small armature conductors, soldering commutator connections and soldering armature band wires, ordinary bar solder is not only unhandy, but also quite

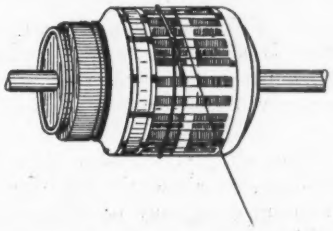

FIG. 3. THE FIRST STEP IN BANDING AN ARMATURE

wasteful. String solder is, therefore, largely used for these purposes, although due to its form, it is somewhat more expensive than the bars.

String solder may, however, be readily made in any shop by making a mold consisting of a ½-in. board, 4 in. wide and 6 ft. long, provided with 10 grooves, each ⅛ by ⅛ in. in section, running the length of the board and pouring molten bar solder into these grooves and

allowing it to harden. A 4 by ½-in. strip nailed to each end of this mold acts as a dam and prevents the overflow of the solder while still liquid.

A mold of a different size and having more grooves may, if desired, be employed, although the specifications for the one shown in Fig. 5 will prove satisfactory for all general purposes.

### Commutator Repairs

Electric motors such as employed in railway and mine service where continually exposed to the weather, frequently develop commutator troubles difficult to locate and repair. Most prevalent among such troubles are grounds. The source of a grounded commutator may many times be found inside the shell accessible only through the removal of the commutator end plate or nut. But as the entire structure is dependent upon the support of this end piece, it is necessary to guard against the collapse of the commutator before this plate or nut is withdrawn.

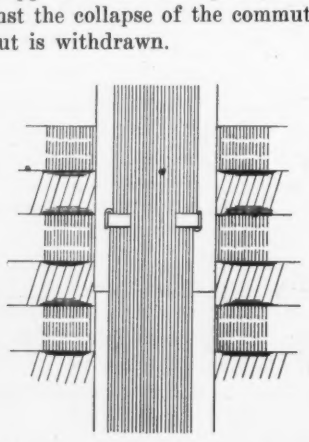

FIG. 4. ENLARGED SECTION OF BAND SHOWING MANNER OF HOLDING END TURNS

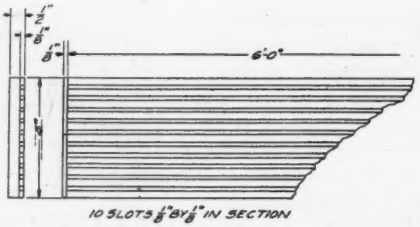


FIG. 5. PARTIAL PLAN AND SECTION OF STRING SOLDER MOLD

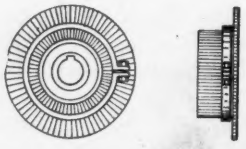

FIG. 6. A BAND LIKE THIS WILL PREVENT COLLAPSE OF THE COMMUTATOR UPON REMOVAL OF THE END HOLDING NUT

To avoid any such collapse of the segments, an employe of a railway repair shop devised the simple arrangement shown in Fig. 6. This consists of a piece of ¼ by 2-in. strap iron of such size and curvature as to fit the standard size of commutators handled and provided with lugs through the holes in which is passed a tightening bolt. Before opening a commutator, therefore, this strap is slipped over the segments up to the risers and securely tightened, after which the end piece may be removed without fear of a collapsed commutator.

But one holding strap is necessary for each standard size of commutator, as allowance for wear and stock removed by turning down may be obtained by the use of sheet-iron fillers.

## The Reclamation of Porcelain Knobs and Cleats

In shop and mill work there is continuous rewiring and to let any material go to the scrap pile that is capable of rendering its original service in any form or at any time in the near future is an indication of business short-sightedness for which spectacles offer no relief.

Porcelain knobs and cleats that have been in service in mills and shops, perhaps for years, if taken down carefully, can be used over and over again by putting them through a freshening process not only to restore their original whiteness, but further to remove oil, grease, etc., that may have worked into the screw holes and grooves.

The writer has treated 2 or 3 batches of such cleats and knobs by dumping a bushel or so into an open watertight vessel, covering them with water, adding a water pailful of dry caustic soda and boiling them up in good shape with a steam hose, allowing them to stand for about 24 hr. in the solution, washing them off thoroughly with cold water and setting them away to drain. These cleats could not be told from new ones when they appeared on different ceilings shortly after being so treated. Soda ash will answer the purpose instead of caustic, as it is a mixture of both carbonate and caustic.

Any suitable source of heat will answer for the boiling, as there is nothing refined about the process.

What applies to knobs and cleats will also apply to a thousand other things about the manufacturing establishment and the man who is alive to his own interests would do well to have the word "SCRAP" posted where he can see it occasionally and when he is not otherwise engaged, he might try to write a definition for it that is in accord with sound business policy.

T. H. Reardon.

## When Man is a Failure

When he has no confidence in himself or his fellowmen.

When he values a success more than character and self-respect.

When he does not try to make his work a little better each day.

When he becomes so absorbed in his work that he cannot say his life is greater than his work.

When he lets a day go by without making some one happier and more comfortable.

When he values wealth above health, self-respect and the good opinion of others.

When he is so burdened by his business that he finds no time for rest or recreation.

When he loves his own plans and interests more than humanity.

When he knows he is in the wrong; but is afraid to admit it.

When he does not care what happens to his neighbor or to a friend so long as he is prosperous.

When he is so busy doing that he has no time for smiles and cheering words.—Ideal Powers.

# Stacks at the Northwest Station

AN OUTLINE OF THE PROCEDURE OF STACK CONSTRUCTION AT NEW COMMONWEALTH-EDISON PLANT

IN THE design and construction of a modern brick lined steel smokestack, the actual procedure is usually as follows:

First must be determined the height and bore of the chimney required to give the required draught; then the weight must be obtained in order to calculate the strength of the foundations and steel towers on which the stacks are carried. Next the strength of the steel plates must be calculated to withstand a predetermined wind pressure and other stresses.

We are now ready to make a drawing. In actual work there are 3 sets of drawings made—first one which is really a mere outline, but which shows the result of the engineer's calculations and the minimum strength of the various parts.

Then come the detail drawings which show the exact size and thickness of plates with the size and position of every rivet and bolt.

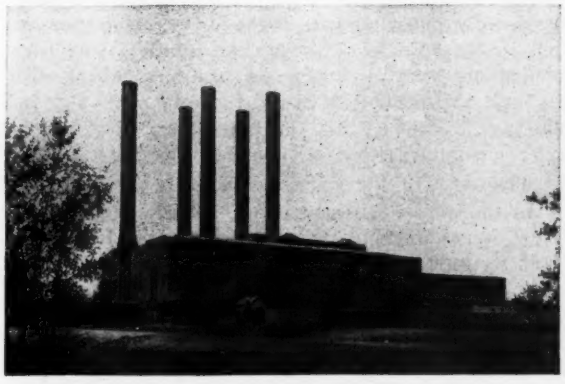

FIG. 1. EXTERIOR OF NORTHWEST STATION, WHICH WILL HAVE AN ULTIMATE CAPACITY OF 500,000 HP.

The details after approval are passed on to the templet maker, who makes a replica of every individual part in cardboard from which the layer-off can set out the steel. While the templet maker is busy the steel is being prepared at the mill, and after receiving the attention of the layer-off, is sheared, punched, rolled and otherwise treated. This completes the fabrication process, and the materials are shipped to the site.

Now, the third, or erection, set of drawings comes into use, for these give the erector the position of every part. It is the aim of every good erector to avoid handling his material twice over, and he therefore sorts out the parts as he unloads them. Then he begins to erect.

This, in the case of the Northwest stacks, was carried out as follows: The base and the bell, with the first ring course, are placed by an ordinary stiff-leg derrick. Then a floating derrick comes into play. This is a platform which is hung on the ring plates already set, and which carries a crane the arm of which can revolve in a complete circle and thus handle the 4 plates which comprise a ring. The 4 plates being riveted, the float is hoisted and attached to them, another ring hoisted and riveted, and so on to the top.

As soon as the order is given for the steel, the inspectors start their work. Every heat of steel is tested, mechanically and chemically, the dimensions of parts and positions of holes checked, and even the painting is carefully watched. During erection the inspection is kept up, joints are tried out and every rivet and bolt tested, for the structure must be made water-tight.

The steel having been riveted up we are ready for the brick lining. This is erected in sections of about 16 ft., each section being carried on a projecting steel shelf, so that should the brickwork loosen up, the damage would be confined to one section. Between the brickwork lining and the steel shell is poured liquid grout, which fills all the crevices and protects the steel from the corrosive action of the gases.

A few figures may prove interesting. The top of the stack is approximately 286 ft. above the ground, or

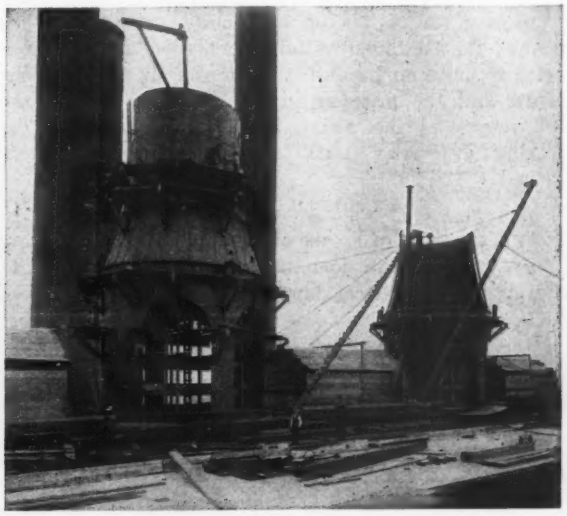

FIG. 2. NORTHWEST STACKS FROM THE BOILER HOUSE ROOF

183 ft. above the roof. The internal diameter is 18 ft. 4 in. There are 4 openings in the base where the flues are connected, each 17 ft. high and 11 ft. wide. The materials comprised in the 2 stacks and 4 flues are: Steel, 376 tons; rivets, 88,900, of which 700 were rejected and replaced (a remarkably low figure); 50,000 fire bricks; 48,000 stack blocks; 1400 book tile; 700 bags of cement; 75 cu. yd. of sand, and 100 bbl. of lime.

Unloading of material at Northwest was commenced on May 8, 1915; preparation for hoisting was completed on June 1. The first stack smoked on Sept. 16, and the second on Oct. 11. Particularly good progress was made on the brickwork lining, each stack being completed in 8 days, including erection and removal of scaffolding.—The Edison Round Table.

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NATURE HAS PROVIDED that all that is worth while and great shall be achieved only through struggle. All that is of value in history was born of effort. To know that progress comes only through struggle and overcoming—that is real optimism. Fight on.—DOCKRELL.

# GAS POWER APPARATUS

*Producers, Engines and Industrial Applications*

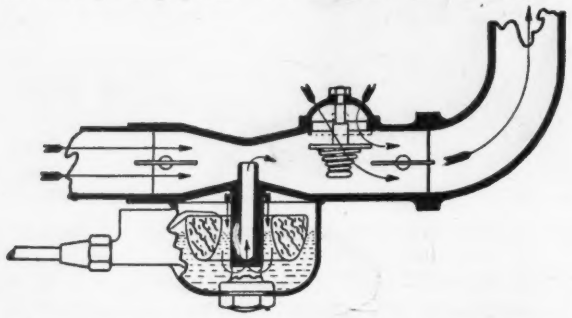
## Carburetion*

METHODS AND TYPES OF CARBURETERS EMPLOYED. BY EDWARD E. DEAN

THE treatment of carburetion in this paper shall be understood to be of the induction principle, that is, one in which the flow of air and fuel is induced and maintained by air displacement. It will therefore be apparent that the flow must vary from zero when the piston is at rest, to maximum velocity, when piston has attained its maximum velocity. So soon as the piston begins to move on its induction stroke, air displacement occurs, and the pressure in the passages between the carbureter and the piston head become negative, decreasing gradually, until the maximum velocity is reached.

### THE SIMPLE CARBURETER

THIS CONSISTS of a tube of constant diameter, having a fuel jet placed in communication with the air flow. The study of physical laws tells us that the flow of



DIAGRAMMATIC FORM OF SIMPLE CARBURETER AND AUXILIARY AIR VALVE

fluids, including gases, within certain limits of pressure differences, is proportional, and is as the square of their velocities.

In a tube of constant diameter, assuming a given flow of air in feet per second, acting upon a fuel jet placed at the point of highest velocities, which would be the center of air stream, and disregarding friction, head, viscosity and other retarding influences, we could expect to induce a given flow of fuel, in feet per second. Now, if the air flow in feet per second be increased 4 times, it follows, based upon the above law of the flow of fluids, that the fuel flow will be increased 4 times. As the quantity of both air and fuel vary as the square of their velocities, it would seem only necessary so to proportion the size of tube and fuel duct, to attain a proportional mixture for all air velocities.

*From a paper read before the N. G. E. A.

If we were dealing with a perfect gas, or were able to deliver the fuel to the air stream thoroughly atomized, homogeneously mixing it with the air, without any expenditure of the energy of the air stream, we might expect a proportional mixture of the air and fuel for all speeds. This, however, is not possible, as we must contend against friction, head, viscosity and other retarding influences which vary with the velocity.

Why does a simple carbureter seemingly deliver an increasingly richer mixture as the air velocities increase? This, in the opinion of the writer, is due to inefficient atomization when air velocities are low, and lack of thorough saturation of the air stream with the fuel molecules. To offset this condition, we must admit fuel under less retardation, or in other words, increase the fuel orifice.

As the air velocities increase, so also does the efficiency of atomization. The increase in the fuel orifice, which we found necessary for low air velocities, now becomes excessive, consequently the quantity of fuel molecules becomes more numerous as the air velocities increase, resulting in an over-rich mixture. The simple carbureter must, of necessity, be limited in its range of capacity, and be, at best, wasteful of fuel.

### THE MIXING VALVE

LET US GIVE a few moments to this device, as a combination of the mixing valve, and the simple tube carbureter becomes the foundation of our present instrument. We are all familiar with the mixing valve, and little need be said here, except to emphasize the fact that its range is far more limited than the simple tube, the tendency being toward rapid impoverishment, as the air velocities decrease with the air valve opening. It will be noted that its action is the reverse of the simple tube carbureter. The mixing valve delivers an increasingly weaker mixture as the air quantities increase, while the tube delivers an increasingly richer mixture under the same conditions.

### THE COMPENSATING TYPE

THIS, as its name implies, is an attempt at correction. Attempts to correct the tendency to over-richness exhibited by the simple carbureter, led to the early adoption of the auxiliary air valve. The popular conception of its function seems to be that of correction, by diluting, with air, the over-rich mixture delivered by the simple tube portion of the carbureter. This is true, but its

dual function is not only to add an extra amount of fresh air, but more particularly to effect a modification of the air velocities at the fuel jet. Its dual effect is to increase the air supply which decreases the tension on the air flow at the jet, and consequently effects a reduction of inspiration, resulting in a weakened mixture.

As will be apparent from the foregoing, the auxiliary portion, be it spring or weight, can serve but one purpose, that is to correct an over-rich mixture, and at but one point at a time. It therefore follows, that no adjustment of spring tension can do more than slightly modify this tendency towards impoverishment of the mixture. The addition of various forms of subsidiary springs, becoming operative only at some point of valve opening, can do no more than correct the error at one given point, and then start, as it were, merely a new scale of errors. This is true not only when springs are used, but is an unavoidable fact when correction is attempted, in this manner, by any means. I would not, however, criticise too harshly, as many of our most successful instruments are based upon this construction, but rather point out the inherent faults that lie in this method.

### Multiple-Jet Type

This may be compared to the auxiliary air type, being an attempt at correction by the addition of jets as needed, and is subject to the same criticism, as pointed out in relation to the auxiliary air valve construction. Results approaching perfection may be attained by this method, but of necessity must be sensible in construction.

The jets in the smaller sizes must be minutely small, if any number are to be employed, with consequent troubles from water and foreign matter in the fuel.

### Variable-Fuel-Orifice Type

This is one in which a tapered valve is withdrawn from the fuel orifice, in relation to the quantity of air passing through the carbureter.

This, in principle, approaches the ideal; however, when we consider that the fuel and air ratio by volume is about 1 to 8000, and as this method is a direct graduation of the one part, its sensitiveness will be readily apparent.

### The Successful Carbureter

This must accomplish as fully as possible atomization of fuel at all working air velocities, and a thorough saturation of the air stream with fuel molecules, consistent with the volumetric efficiency of the motor, and must so deliver the mixture to the manifold.

It must be simple, with no more moving parts than absolutely necessary. Its principle must consist in controlling the air pressures which directly effect inspiration.

The term gasoline as applied to gas engine fuel is indefinite in its application, being used to cover a range of distillates embodying a large percentage of the more volatile portion of the crude. Its specific gravity is rapidly increasing, until today it is encroaching upon the less volatile series from which kerosene is derived. Both are subject to temperature effects, made manifest in viscosity, vaporization and atomization. All are negligible quantities in the process of carburetion and must be carefully considered.

Air supply is unlimited, but requires careful study in its combination with fuel oils. Unlike liquids, it is elastic, and its volume may be controlled by mechanical construction. It is also affected by temperature. Its volume varies inversely as the pressure, and directly with the temperature rise. It also acts as a medium of fuel transportation, thoroughly enveloping the fuel molecules in transit to the combustion chamber.

### Some Problems of Kerosene Carburetion

To utilize successfully kerosene or other fuel oils in an internal-combustion motor, it becomes necessary to deliver the fuel charge to the combustion space, thoroughly saturated with the fuel molecules, in a correct proportion for all air velocities. It is necessary to effect a thorough saturation of the fuel stream with fuel molecules, maintaining a proper mixture proportion under all operative conditions, and deliver it to the manifold for transit. The accomplishment of this depends upon several factors.

### Correct Design

This is one in which the air velocities must be maintained sufficiently high at all speeds to effect a thorough atomization of the fuel stream from the jet and at the same time not so high as to cause wiredrawing, resulting in a partial charge and loss of power.

### Heat Applied

The writer would consider the process of carburetion of air and fuel as one of 3 stages; the carbureter being responsible for the first stage, the manifold and inlet passages the second stage, and the period of compression as the third and final stage.

Assume that the mixture has been delivered to the manifold in a thorough state of saturation as the completion of the first stage. Throughout the second stage, this thorough admixture of air and fuel not only must be maintained, but must be assisted by partial vaporization, and delivered to the third stage. In the third stage occurs gasification due to compression.

Compression accomplishes at least 2 things, a closer co-mingling of the fuel molecules with the air, resulting in rapid flame propagation. This is assisted materially by the rise in temperature due to compression and heat from the cylinder walls.

Summarized, we find—First stage, atomization; second stage, vaporization; third stage, gasification. If these 3 stages be accomplished successfully, the use of fuel oils will be possible.

We will not attempt to enter into any mathematical equations for attaining the loss of heat in a column of air passing through a carbureter. Suffice to state that the temperature of the incoming air is subject to considerable change, dropping practically 50 per cent, under normal conditions. This is due to at least 2 causes: Expansion after leaving the tube restriction, and loss due to evaporation of the fuel.

As kerosene begins to give off a vapor at about 80 deg. F., it follows that the temperature must not fall below this figure at any time, and should be somewhat higher, consistent with volumetric efficiency.

To offset this temperature drop; we may increase the temperature of the incoming air. However, this is not sufficient. If we could maintain a suspension of fuel molecules in the air stream without any deposition, this would be sufficient. Unfortunately we must have bends

and turns in fuel passages, and as the fuel molecules have a greater specific gravity than the air, they will be impinged or thrown against the sides and remain in a liquid state. This means an impoverished mixture which must be avoided, and can be by applying heat to the sides or walls of the manifold. This will materially assist in re-vaporizing these molecules and sending them back into the air stream.

### Heat Application

Modern practice seems to point out the advisability of applying heat to assist carburetion. There are at least 3 practical methods being used successfully, raising the temperature of the intake air, heat jacketing the manifold and applying heat directly to the fuel supply. The successful burning of the lower grade distillates depends upon at least the 2 former means. The third may be employed with good results.

In the application of heat we are attempting to maintain a temperature within the carbureter and the passages sufficiently high to assist and maintain vaporization. This is best accomplished through the medium of raising the temperature of the intake air. Preheating the fuel will assist in atomization, but owing to the extremely small amount entering the air stream it can have but slight effect in maintaining the necessary temperature for vaporization.

Applying heat to the fuel passages is necessary, especially where the charge has some distance to travel. Deposition of fuel must inevitably take place, and unless this can be gotten back into the incoming charge, it must arrive at the combustion space in an impoverished condition. It is therefore essential that heat be applied to the manifold, and brought as near to the carbureter as possible.

As the specific gravities of fuels increase, so should the temperature of heat application increase. With the present-day gasoline, much benefit could be derived by jacketing the manifold with hot water throughout its entire length, but with kerosene; hot water is not sufficient. Exhaust gas must be used.

Here arises a situation which does not lend itself to direct application when best results are sought. At low motor speeds when air velocities through the carbureter are low, and atomization is incomplete, we should have the highest temperatures, especially around the manifold jacket. The temperature and the quantity of the exhaust gas is limited at this time. Therefore, the supply of exhaust gas is inversely proportional to the needs. To offset this condition, a governing means might be employed, so as to utilize all of the exhaust at low speeds, controlling it as much as may be found necessary for increase in speed.

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Report from Washington State shows an active movement under way for the construction of a dam in the Z Canon of the Pend D'Oreille river, the dam to be set into solid rock at a point where the banks are only 20 ft. apart and the walls 400 ft. high, so that the building of a 400-ft. dam would be comparatively easy. The construction of this great source of power would change the conditions in Northeastern Washington, but the permission depends on the action of Congress, to which the whole matter will be presented during the coming winter.

# The 2-Cycle Diesel Engine

By Chas. Labbe

IN THE practice of the stationary gas engineering, the 2-cycle unit has never met with favor on account of the non-economical use of fuel. Although giving more power for its size, the number of 2-cycle stationary engines is exceedingly small in comparison to that of the 4-cycle. The 2-cycle engine has, however, met with favor where light weight and power were the main considerations, as in motor boats, autos, etc. But with the coming era of the Diesel engine of both the 2- and 4-cycle types, more attention will be given to the 2-cycle engine.

An important point to remember in the 2-cycle Diesel engine is that on or before the return stroke, according to builders, the scavenging is done by air alone and fuel is admitted only at the end of the compression stroke, no waste of the mixture of air and fuel exists, as in the common gas engine of the 2-cycle type.

Of course, in the 2-cycle engine there is a slight loss caused by the exhaust port opening somewhat earlier than in the 4-cycle type; but as already mentioned, the admission of fuel at the end of the compression stroke only is of importance.

If you take into consideration the troubles and wear, leaky valves, slipping of cams, etc., and the power necessary to operate them, I believe a valveless type of Diesel engine will be as economical as the engine with 2 valves.

A desirable feature would be the injection of fuel into a combustion chamber instead of being forced directly into the cylinder, because, if the walls of the cylinder are to vaporize the fuel, the lubrication will be greatly impaired and with high temperatures lubrication deserves full attention. The piston receiving an impulse every revolution ought to double the power for the same size as a 4-cycle engine and the regulation should be better when operated with an impulse every revolution instead of every 2 revolutions.

The 2-cycle type of Diesel engine will be in favor for places out of means of communication and where the freight is one of the main items to be taken into consideration. I am in favor of simplicity in building and running engines, and despite breakdowns, hurry-up repairs that never hold, night work and other drawbacks, the 2-cycle Diesel engine has gained my favor.

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Professor G. A. Goodenough of the Department of Mechanical Engineering of the University of Illinois, has undertaken an analytical study of the stresses in convex boiler heads, and it is expected that actual experimental work to verify the analytical results will be undertaken by Professor H. F. Moore of the Department of Theoretical and Applied Mechanics. It is hoped that this investigation may lead to a more rational and safer design of boiler heads. The Babcock & Wilcox Co., of Bayonne, New Jersey, presented a 42-in. cylindrical drum to be used in the investigation. One head is provided with a manhole, and the other, the head to be tested, is fastened to the shell by specially designed tapered bolts to facilitate its removal and replacement by heads of different design. The shell of the drum is made unusually heavy to permit pressures to be carried above those normally used in practice.

# Flywheel Explosion

TOTAL WRECK AT MANSFIELD, OHIO, WHEN STARTING UP ENGINE

IN A wreck which occurred in the plant of the Mansfield (Ohio) Railway, Light & Power Co., on Sept. 22, damage was done resulting in shutting down most of the plant, and the night engineer, Charles E. Moore, was killed by flying debris.

Shortly after 10 o'clock, as the load began to decrease, Mr. Moore made ready to start a 250-hp. belted unit which was used to carry the light night load. As he turned on steam, the governor, according to L. R. Brubaker, who was an eye-witness, refused to work, and, apparently the throttle stuck so that before Mr. Moore could close it off tight, the crash came. All spokes were torn from the hub; the rim flew in fragments through the roof, floor and partitions, the pillow block was thrown sidewise through a window, and the generator pulley was partly splintered.

The fire department was summoned to the plant, but, luckily, no fire ensued. The men, however, found the body of Engineer Moore under a heap of brick and wood near the throttle, which he had tried, vainly, to close in his effort to save the plant.

While there was plenty of generating capacity (a 1500 hp. and a 750 hp. unit) left uninjured in the plant, it was thought by the management unwise to start this until examination and repair could be made to prevent further damage from falling walls or timbers due to possible vibration, since many roof beams were torn from their places and left insecure. Some power was, therefore, secured from the Cleveland Southwestern Co. for emergency use and every effort made to fit the Mansfield plant for full operation by the following Monday.

In view of the flying pieces of the flywheel and the mass of brick and wood, it was fortunate that there were no other casualties, for a piece 6 ft. long and weighing some 1000 lb. was thrown through the roof and across the street.

Mr. Moore had been running as an engineer in Shelby, Ohio, for 6 yr., 4 of these with the Shelby-Light & Power Co., and had been operating at the Mansfield plant only 2 weeks. He was 43 yr. of age and is survived by a wife, two daughters and a son.

## How to Clean Leather Belting Before Treating

SOME MEN think it a hardship to have to clean belts, but the improved service derived from any cleaned belt will many times repay the small effort.

Cleaning is not absolutely necessary any more than is the cleaning of shoes before polishing, but belt treatment on top of dirt or hard, smeary belt surface cannot be expected to do its best work or produce the right results. In every instance, before treating the belt, the face of the belt should at least be lightly wiped or dusted off before applications are made.

The best way to clean a leather belt is to wash well or scrub with a brush with a cleaning mixture composed of 2 parts gasoline or naphtha or petrol and one part turpentine. Never, however, use gasoline, naphtha, and the like on rubber or balata belts. Seventy-six per cent specific gravity naphtha or gasoline should be used, as low grades, like painter's naphtha, contain oil and leave the belt greasy. The softened dirt can then be scraped off with an old file or dull knife. This washing and cleaning should be repeated until bare clean leather is reached. The belt should then be dried before treatment is begun.

DAMAGE AT MANSFIELD, OHIO, FROM FLYWHEEL EXPLOSION

Another way is to apply hot treatment to soften the dirt and then scrape off the dirt. The softened dirt may roll up on the pulleys or come off in rolls or flakes looking like pieces of thin black leather. These should be removed and the loosened dirt scraped off, taking care not to scrape hard enough to injure the belt surface.

Still another way, is to have a round tank with a cover and a drip near the bottom, and large enough to accommodate the belts used and deep enough to cover them when raised a little off the bottom. The tank can be nearly filled with the cleaning mixture and the belts put in in a loose roll and allowed to soak for several hours. The belt may then be squeezed between rollers or a press, if desired, to force out all the grease, and finished as mentioned before.

Inasmuch as naphtha and gasoline are highly inflammable, the cleaning mixture and the fume-laden belt after removal therefrom should be kept at least 200 ft. from any fire. If the tank method is used, it is advisable to keep the tank covered to prevent evaporation.

N. G. NEAR.

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A ROCKFORD, ILL., lineman claims to have climbed 800 mi. in the last 12 yr. This is an average of 25 40-ft. poles a day.

# LETTERS DIRECT FROM THE PLANT

*Cash Paid For Ideas Accepted. Sketches Desirable.*
*We Make The Drawings*

## Putting Babbit Ring on Follower; Improving Graphite Feeder

WE HAVE a heating system here in which a vacuum pump is used to return condensation to heater in boiler room. This pump was thoroughly overhauled in the late fall, repacked, etc. Nevertheless, after running about one week it fell down completely. On inspection it was found that the condensed water had corroded the follower in the water end to such an extent that the packing had pulled through, worked up into valve seats, etc. It would have been a simple matter to turn the follower down and put a band on it, but we had no lathe, so we solved the problem in the following manner: First, we trued follower up on emery wheel, as to circularity, then ground edge of follower concave or grooved as at A. Then we turned mold on wood lathe same size as pump cylinder and same depth as thickness of follower plate, as at B, centered follower plate in B and filled with babbit. The job gave excellent results.

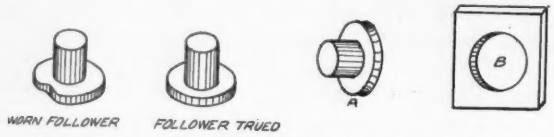



FIG. 1. CORRODED FOLLOWER AND REPAIR

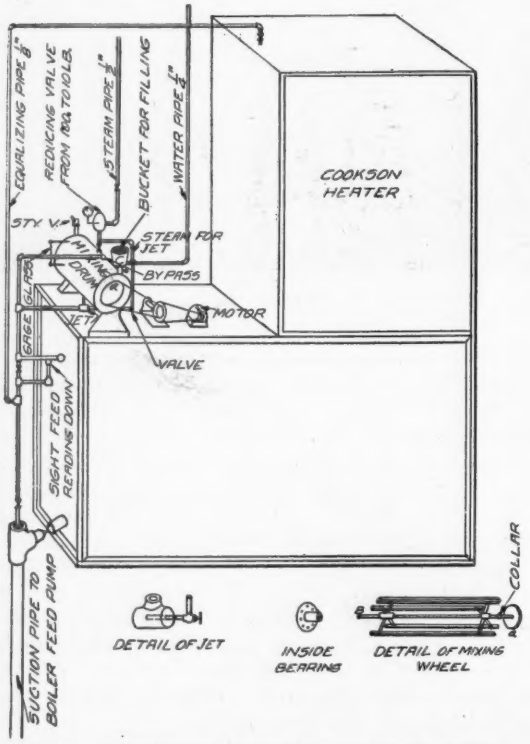



FIG. 2. REARRANGED PIPING OF GRAPHITE MIXER

After experiencing considerable difficulty with the feed pipe on our old boiler graphite feeder clogging up and corroding of the iron mixing paddles,we made some changes which resulted in much more satisfactory operation.

Graphite is first mixed in a bucket with hot water and poured into mixing drum through bucket C, which has funnel shaped strainer inside. The water pipe is for adding more water, since the water mixed with graphite is not sufficient to feed all the graphite through the mixer. The drum should be filled and run through till water is clear.

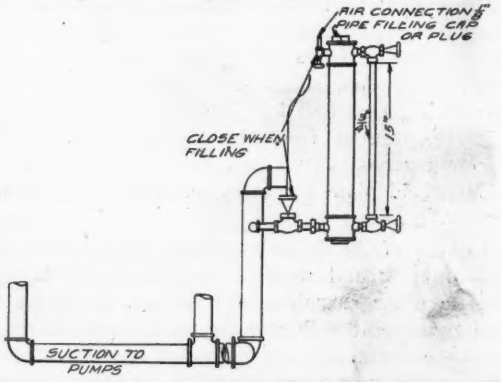
The jet shown is made of a ½-in. T bushed to ¼-in. at one end and center, inside end of ¼-in. pipe is tapped and ⅛-in. nipple screwed into it. By turning steam through this jet (in place of direct to mixing drum, as heretofore) we got a constant flow through feed pipe and up through bypass which keeps feed pipe clear and helps to mix.

Parts of an old lubricator were used to make a sight feed. Pulleys made on wood lathe and for ⅜-in. round belt were used. The reducing valve came with heater and cost about $2.50. Safety valve came with the heater, set at 10 lb. Shaft in mixer was made of ½-in. cold drawn steel. Blades of the mixer are of oak wood 1 by ¾ by 24 in.

A. P. SITTON.

## Compound Feeder

HAVING NOTICED a number of articles describing boiler compound feeders, I would say to any and all, if you have any air under pressure, on or about the premises, the sketch shows you how to make and operate a feeder that I think is hard to beat.




COMPOUND FEEDER WORKED WITH COMPRESSED AIR

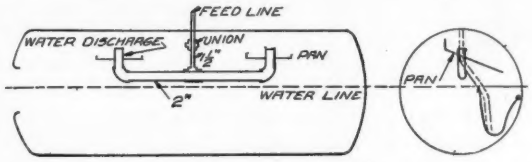
In the first place, you never have to empty it of any liquid before filling, the air does that for you.

The amount and time are under control according to the amount you use. It is hardly necessary to go into details as to operation, which is simple after being set in place on suction line. Turn on air to empty, turn off air and discharge valves and remove plug to fill up, use a little air pressure to force compound to pump suction and regulate with the valve on the discharge line. Glass shows liquid moving down, and a string on glass helps to regulate flow. I use 15 lb. air. All the pressure required is above height of head in heater. A ⅛-in. pipe is tapped to nearest air line.

JOS. WEBSTER.

## Preventing Scale in Stirling Boilers

THE FEED WATER formerly went through a crooked 1½-in. pipe and discharged into a trough. Now the water enters in the same place, through a 1½-in. pipe connected to 2 by 2 by 1½-in. tee, then pipes lead out each way to ells and short pieces of pipe cause the water to discharge upward.




CROSS SECTIONS SHOWING ARRANGEMENT OF SCALE PANS FOR STIRLING BOILER

The water flows out of each pipe onto pans, then down to the trough as in the first case. Hard scale collects on the pans but a large percentage of the scale comes down in slush form and can be blown out at the lower drum. By this scheme the hard scale is precipitated on the pans instead of the back tubes and can be easily removed.

E. CARTER.

## Some Experiences in a Packing House

WE HAD a Vilter 60-ton refrigerating machine and a Hercules 30-ton dry gas machine.

When I took the job, a man wasn't supposed to leave the engine room, and the chief engineer would make the day run so slow that the night man did the the most work. We had part direct expansion and part brine system, but we used the direct expansion only.

One Sunday we started up the Hercules, the Vilter being down for repairs. The chief said everything was ready and went home. The machine hadn't been run for a couple of years and they left it up to me. I started and pumped down, and opened the liquor valve and the frost and liquor came back to the machine like a cyclone. I shut off the liquor and began to pump down. The day watchman professed to know all there was to know about the business, and it nearly scared him to death. He came down in the engine room on the jump, and said the coils were jumping and pounding and he didn't know what to do. Well, I got her warmed up and put her on her hooks and went up in the rooms. We had 4 hot hog rooms on and it was going to be a hot day. When I got up there, I found the expansion valves wide open, and the liquor had the right of way to the compressor. I pinched them down until I heard the compressor breathe, and went down to the telephone and called the chief and asked him if he opened the expansion valves wide open, and he said, "Practically, yes." We had the old hand valves to work with. I told him the machine was freezing up, and he said that probably there was some liquor lying along the suction line somewhere; but I told him it was full, and it was.

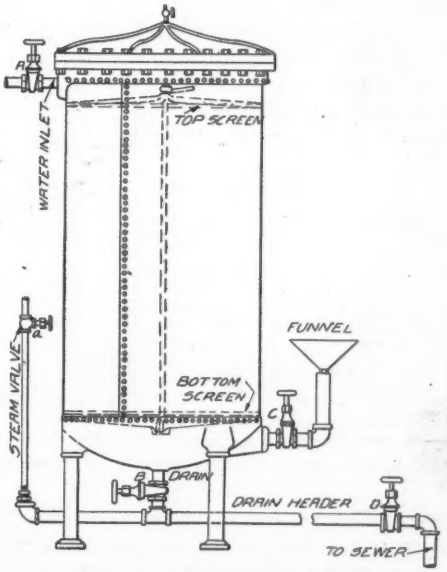
It ran all right after that, but the chief found he couldn't make a wet gas out of a dry gas machine.

P. J. Cox.

## Cleaning Charcoal Water Filter

FOR CLEANING the charcoal in a so-called downflow distilled water deodorizer or filter, the following has been found successful:

Referring to the accompanying sketch, the operation is as follows: First remove cover plate or top of filter and drain water to sewer through valve B, seeing, of course, that valves A, C and a are closed. Disconnect pipe line between valve C and adjacent filter (if more than one), and insert a short piece of pipe and funnel as shown.




CHARCOAL FILTER SHOWING CONNECTIONS

Now close drain B, open valve C and empty a 10-cent can of concentrated lye (sal-soda would probably do as well), into the funnel and pour in a bucket of hot water or at least sufficient to wash the lye into the vacant space below the lower screen.

Now close valve C and fill filter from below if possible; if not, then through inlet valve A, to about the level of the top screen. It will be well to loosen the nut on long rod (used to hold top screen down) so that the packed charcoal can loosen a bit.

Then open steam valve a, drain valve B (being sure, of course, that drain valve D to sewer is closed), and let water gradually come to a boil. The expansion of the water will raise its level until it overflows the top of filter. The lye will be in thorough solution and the boiling water and lye cut the oil loose from the charcoal,

whence it rises to the surface and skims over. This boiling should continue about an hour, a little water being added from time to time to replace that which has skimmed away.

If the charcoal is very dirty, it may be necessary to drain the filter a second time and give another injection of lye and an additional boiling.

In any event, after boiling with lye water, the filter must be drained, refilled with fresh water and boiled, repeating the operation until convinced that all lye has been washed away.

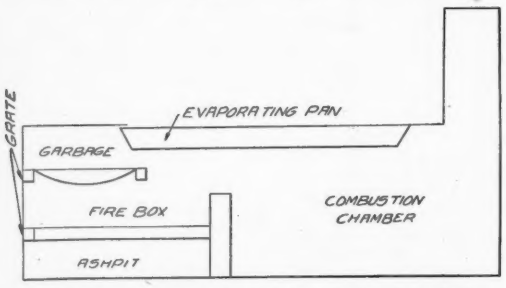
The connections outside of valve C should be put together and water run through from below until it overflows perfectly clear. Upon examination, it will be found that the charcoal is clean, and almost as good as new.

The cover can now be replaced and the filter placed in operation. R. B.

## Burning Garbage at the Army Camp

HERE IS a word from the border. One of the troubles of the main camp of the army is garbage disposal. They have tried several types of incinerators but none has been satisfactory, it seems.

Recently I requested permission to try my hand at making one and as no brick mason was in our company, I got the job, also permission to forage the country for grate bars discarded from pumping plants. The sketch shows the design, which proved successful.




SUCCESSFUL ARMY CAMP GARBAGE INCINERATOR

Wood is used for fuel, tin cans are dried in the back connection and bottles in the ash pit. Heavy garbage is placed on the top grate to dry and burn, and slops in the pan to evaporate. We also heat water for washing on the same incinerator.

It has 800 bricks laid mostly in dobe mud, uses comparatively little wood and serves its purpose well. It has the reputation in our camp of being the most amateurish and most scientific incinerator in Texas.

B. C. WHITE.

## Oil Washer and Settling Tank

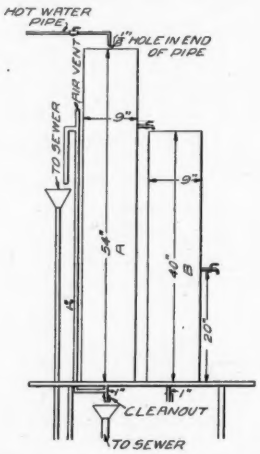
IN THE ice plant where I am employed as engineer, our motive power is a 50-hp. De La Vergne Type HA oil engine. The waste oil from bearings and cylinder contains a quantity of carbon which would clog up a filter employing cotton waste.

Being able to obtain 2 drinking water tanks from railroad passenger cars, I made an oil cleaner, as shown in the sketch.

A couple of buckets of dirty oil are poured into A and hot water is allowed to run through it 5 or 6 hr., when it is drawn off into B, closing the valve when dirty oil appears. In B the clean oil is allowed to settle 5 to 10 hr., when it may be used.

The size of the hole in the end of the hot water supply pipe must vary according to condition of oil and temperature of water, but must not be large enough to wash away the oil when turned on full. The hotter the water—without boiling—the better and quicker the oil will clean.

The overflow from A should be made so as to lower or raise the level of oil which is to be left just high




ARRANGEMENT OF TANKS FOR CLEANING OIL

enough to run nicely into B when the valve is opened. The whole should be set on a bench high enough to draw the settling and water from B which is dumped into A.

We are using Polar ice machine oil in the ammonia and engine cylinders. All waste oil, except from ammonia separator, is put through the filter and used on the bearings.

The cleaner has been in use over a year and works fine. WM. SMIRES.

## Was His Resignation Accepted?

"GENTLEMEN:

"My conscience tells me that I should resign my position as chief engineer of your plant; therefore, I regret to advise you that I must take that step, and for the following reasons:

"We now have a central station in our city which is selling current to consumers at a price lower than our own cost of production. You will therefore save money by discontinuing the use of your own power plant, selling the machinery, utilizing the space for better purposes, and, of course, by dispensing with the services of your chief engineer, assistant and fireman. Rather than lose money, as you are now doing, you should change over to central station service.

"You doubtless remember that during the past 10 yr. I have constantly urged newer and better equipment and have exhausted every means at my command to show how uneconomically your plant operates under the very best care that we can give it. That my urging has had little effect is easily proved, for we have been per-

mitted to add only $200 worth of new equipment during my employment.

"An expenditure of only $1000 will enable us to BEAT the central station rates. With $2000 we can do still better. But the minimum investment in new equipment should be $5000."

Two weeks later the governing board of the Hardy-Wilkins Co. appropriated $8000 for their chief engineer, to be used as he saw fit.

And as the smoke curled upward from the 5 cigars around the table a sixth smoke was produced on a platter at the center of the table. It came from the blazing resignation.

The governing board smiled unanimously as they then continued their work. N. G. NEAR.

## Vacuum in Receiver; Seal for Barometric Condenser

IN ANSWER to the question relative to whether or not it is dangerous to have a vacuum in the receiver of a compound engine, I believe it depends upon the conditions under which the engine runs.

I know of one case in which the low pressure side of a compound engine was wrecked under these conditions.

During the last hour's run water was put on to the water wheels to enable the fires to be burned down for cleaning. The load lightened up on the engine and the volume of steam used was less so that a vacuum was created in the receiver, a sketch of which is shown in Fig. 1.

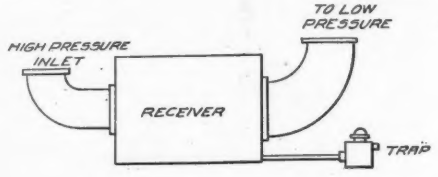



FIG. 1

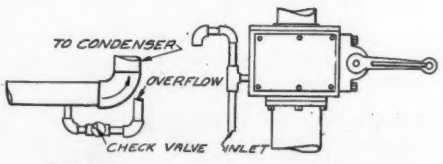



FIG. 2A FIG. 2B

FIG. 1. ARRANGEMENT OF RECEIVER ON WRECKED ENGINE
FIG. 2. WATER SEAL ARRANGEMENTS FOR CHECK AND ATMOSPHERIC RELIEF VALVES

A pressure type of steam trap was installed suitable for low-pressure work, but of course worthless when a vacuum is in the receiver. In the case referred to, the trap could not discharge, so the receiver practically filled with water and when a heavy motor load came on, a portion of the water entered the low-pressure cylinder resulting in a broken main bearing, bent rod and broken piston.

Whenever the load conditions are such that a vacuum can be created in the receiver, both pressure and vacuum traps should be connected to the receiver. Several methods of connecting drains to receivers have appeared in Practical Engineer.

It is always desirable to raise the receiver pressure and open a hand operated drip on the receiver before shutting the throttle for safety.

The automatic drain for the exhaust pipe shown on page 752 of the Sept. 1 issue of Practical Engineer is good, the writer having had them in use several years.

Mr. Marier can improve the device if he will connect 2 short nipples and an elbow into the check valve as shown in Fig. 2A, the idea being to give the check valve a water seal, for we all know that oil and scale which all pipe sheds at times has a way of depositing itself between the valve seat and disc and should frequently be cleaned off.

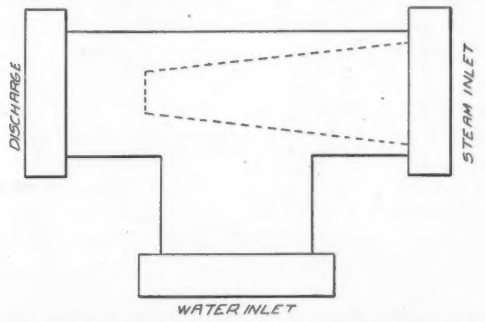
Some makers of barometric condensers provide a casting to house the atmospheric relief valve similar to that shown in Fig. 2B. When it can be done, a small pipe should be connected to supply the relief valve disc seat with water to seal it and thereby make it more secure against leakage, because low vacuum in most cases means increased cost of operation.

The loss in power due to poor vacuum can be figured like this: Approximately each inch of vacuum is equivalent to 0.5 lb. pressure. If the engine constant is 6.55 and the vacuum usually carried is 26 in. and only 20 is available, the difference is $26 - 20 = 6$ in., and $6 \times 0.5 = 3$ lb. increase in back pressure per square inch on the piston, so the horsepower represented is $3 \times 6.55$, or 19.65, calling for a correspondingly later cutoff to enable the engine to run at the regular speed.

RECEIVER.

## Instantaneous Water Heater

THE ACCOMPANYING sketch illustrates an instantaneous water heater of which I have over a hundred of various sizes being used when wanted in the plant of which I have charge, and they don't want anything else, because it is so handy and free from trouble. It will also work as an ejector if wanted for that purpose. The cast fitting is a McDaniels suction tee, made here in Philadelphia, in all sizes.



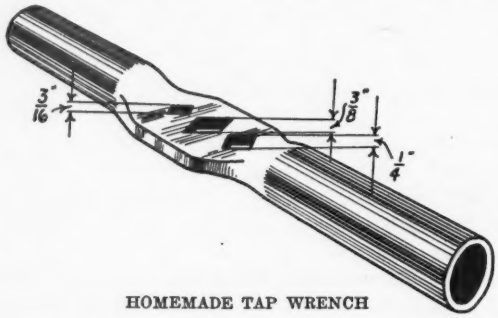

SIMPLE EJECTOR TYPE WATER HEATER

Steam is connected as illustrated at the conical inlet end. Water is connected at side inlet. Discharge is the end opposite steam inlet. It is important to couple up as directed; any other way would probably blow the water back away from the tee and cause water hammer.

I use sizes for steam inlets ¼ or ⅜ in. for tees up to ¾ in.; ½ in. for 1 to 1¼ in.; ¾ in. for 1¼ to 1½ in.; 1 in. for 1½ to 2½ in. tees. These sizes can be altered to suit the installer's ideas. The shape of the fitting or suction tee is like sketch. WM. E. ADAMS.

## Handy Homemade Tap Wrench

IN A RECENT ISSUE of the Electrical Review and Western Electrician, J. McIntyre, describes a readily-made tap wrench for emergency use. It is made from ½-in. gas pipe 12 in. long and, as shown in the accompanying

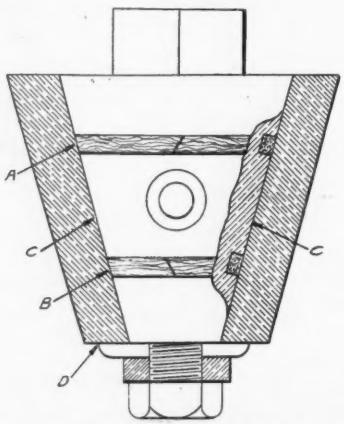



HOMEMADE TAP WRENCH

illustration, in the middle a portion about 2 in. long is hammered flat. Three square holes are made in this part by first drilling and then filing square. This makes a good round handled tool.

## Stopping Leak in Plug Cock

THE ASH EXPELLING system fitted in this plant is operated by the water jet system. For control of the water supply to the nozzles of these hoppers, 3-in. one-way plug cocks of the plain cock and body type are used; that is, there are no packing glands or other means to keep the cock from leaking. The only way possible to keep them tight, before this alteration, was to regrind the plug to its seat in the body, and this would not last very long before it would leak again. It also was neces-




PLUG COCK FITTED WITH PACKING RINGS TO PREVENT LEAKING

sary to set the plug up extra tight into the body, making it hard to operate. Cocks on these water jet expeller systems must operate quickly and easily; for if the cock is stiff and has to be opened slowly, there will be back rush of water, the hopper will flood and will not operate.

The taper plug was removed from the body and put in the lathe and the taper attachment set over so that the grooves shown in the illustration at A and B were cut square with the face of the plug ¼ by ¼-in. These grooves were then filled with one turn of packing cut to an exact diameter to fill the circumference, ¼-in. packing will be just about 1/64 in. above the surface of the plug. When the plug is replaced and drawn into the body tight, this turn of packing makes it impossible to leak water out of either end of the plug; when the packing becomes wet it swells, helping to keep the plug tight. The plug is easy to operate both when idle and when against a pressure of 250 lb. of water.

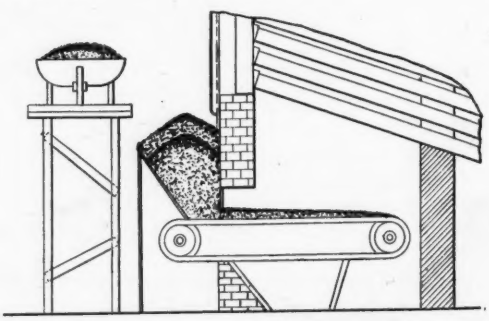
It will be found that unless care is used to see that not more than 1/64 in. of packing is above the face of the plug when replacing it in the body, when closed against a pressure it will leak around the plug into the hopper, through spaces formed at C, as too much packing above the surface prevents the plug from being drawn home against the seat in the body.

The washer at D should be just the right thickness to enable the cock to be seated and still have the nut at the end of the plug drawn up hard against the shoulder on the plug. C. H. W.

## Feeding Stokers During Emergency

RECENTLY, during our season of heavy load, the coal bunkers above the boilers were found to be in bad condition and their use was discontinued.

Pending repairs, it became a problem as to how the coal could be fed to the stokers without the use of excessive labor.



TEMPORARY PLATFORM FOR FEEDING STOKER HOPPERS

This was solved by building up a simple but substantial runway along the boiler fronts, of such height that a barrow could be wheeled along and dumped direct into the stoker hopper without further handling.

This arrangement, as shown in the sketch, served our purpose exactly and enabled us to take care of our coal requirements even when carrying the heaviest loads without undue inconvenience or labor. M. SALLER.

WHAT IS BELIEVED to be the largest natural draft cooling tower so far built has recently been completed at the Anderson, Ind., plant of the American Steel & Wire Co. This tower is of the Wheeler-Balcke type built by the Wheeler Condenser & Engineering Co., of Carteret, N. J. The tower is approximately 150 ft. long, 50 ft. wide and 75 ft. high and has a yellow pine frame with cypress sheathing and filling. The tower has 2 chimneys which rise above the cooling stacks and create the air circulation by natural draft. The capacity of the tower is 7300 gal. a minute cooled from 115 to 85 deg.

# Questions Answered and For Answer

*Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp*

## Peculiar Boiler Behavior

HAVING EXPERIENCED some trouble with my heating system, I thought possibly you might help me find a remedy.

Two 60-in. by 16-ft. Casey-Hedges horizontal return tubular boilers are employed to heat a 6-story hotel building by means of the return system and with a working pressure of from 10 to 15 lb., depending upon the outside temperature. Natural gas is used as fuel.

But one boiler is used at a time except on certain occasions, when the water takes peculiar spells and will not stay in the boiler. You may be using 2 burners and put on the third and have as much as 2 gages of water, and the water will begin to fall and fall rapidly for about 3 to 8 min., carrying the water out of sight, even though feeding considerably. Also, when extra burners are added, the same thing happens. At other times, there are no signs whatever of this trouble.

After the water has left the boiler for a few minutes, it will not only return, but more water than before will appear to be in the boiler, while there will be practically no available steam. When this occurs, the pipes begin to hammer.

We carry full boiler pressure on the heating system and the water of condensation is returned by way of large pipes into the lower rear end of the boiler.

We have no pumps or exhausters and carry the water as low as conditions permit, using pure artesian water as feed. The boilers have perforated dry pans and are kept clean.

The water in the boilers is changed quite frequently, and it is about 3 days after such a change that the trouble begins.

The system has been in use about 10 yr., during which time it has off and on worked this way.

W. M. S.

A. You say that you have no trouble for about 3 days after you change the water in the boilers, so that it seems that the trouble is caused by foaming of the water, thus throwing up water into the steam pipe. This, of course, would be more pronounced with a heavy load—that is, when the boilers were forced. This could happen, also, when an unusual draft of steam occurred, as, for instance, when a number of radiators were opened at once, thus lowering the pressure of steam in the main and in the boilers and causing the steam in the water to be liberated rapidly and causing rapid boiling of the water and consequent foaming. The water thus collected in the steam mains would go by the nearest drips into the returns, filling the return pipes and return risers, causing snapping and water hammer in the mains and finally going into the boiler through the returns and filling the boiler.

If the trouble is not of the above character, it may be due to leaky check valves in the return lines, or there may not be any check valve in the main return near the boiler. If pipe scale or other foreign matter should lodge under the clapper of the check valve and hold it open, it would be the same as though there was no check valve there at all, and the water from the boiler would surge back into the return pipes at will. If the steam pressure at the steam main should be dropped slightly, due to a sudden draft of steam, this would mean that the pressure in the drips from the ends of the mains and all riser drips would have a lower pressure too, and the water standing in them would rise to balance the pressure which, if there were many risers, would take more or less water from the boiler and in this way dropping the water line. Now, in a short time the radiators would fill with steam and the amount of steam flowing from the main would be growing less, and the pressure would build up in the main and send the water back through the returns into the boiler again. The water which has thus been carried into the steam pipes will take a little time to get back into the boiler, and if the return pipes are large, they will hold a great amount of water which is liable to be sent back to the boiler with a rush, thus flooding the boiler.

It seems that the basement which contains the boiler must be low studded, causing the steam mains to be low and requiring wet return mains, which hold a great deal of water and rob the boiler sometimes.

The writer has had some experiences in this line in which remedy was found by taking the steam from both ends of the boiler or putting in a larger supply pipe. We would suggest that the check valve on the return pipe be examined also. It is largely a matter of guesswork in this case, as no data was given as to description of plant, regarding heights of pipes above boilers, horizontal distances of pipe runs, position of drips, etc. A photograph of boiler and connections, if it is possible to get one, would help greatly in solving problems of this type.

S. E. BALCOM.

## Construction of Westinghouse Compound Engine Pistons

WHY DOES the low-pressure piston in the Westinghouse compound engine differ in size from the high-pressure piston?

SUBSCRIBER.

A. Pistons of the trunk type are employed in the Westinghouse single-acting compound engine. In order to have the low-pressure piston exert as great a turning moment as the high-pressure piston, it is necessary, as in all compound engines, to increase the size of the low-

pressure piston. It is for this reason that the upper part of the piston of this engine is larger in diameter than the high-pressure piston.

As you undoubtedly have already noted, the lower end of the low-pressure piston is smaller in diameter than the upper end, its lower end being, in fact, of a diameter equal to that of the high-pressure piston. It is necessary that this form of construction be employed, as otherwise the large low pressure piston descending would, on account of the enclosed crank case, cause a considerable back pressure on the high-pressure piston. The additional area caused by the increased piston diameter on the low-pressure side is caused to act upon an air chamber out of which the air is discharged during every downward stroke, and into which the air is drawn upon every upward stroke, an automatic valve being provided for this purpose. O. H. H.

## Coast Artillery Reserve Corps Examination

FOLLOWING is a list of questions, together with answers, recently asked in a Coast Artillery Reserve Corps examination for enlisted specialists.

1. (a) How are chucks classified?

(b) State the advantages of each of the various classes.

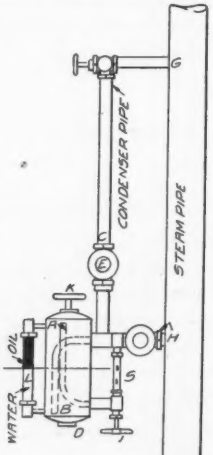
(c) What machine tools are usually found in a well equipped machine shop?

2. (a) How are hammers classified?

(b) How are chisels classified?

3. (a) Explain how you would cut a key-way on a shaft.

(b) Explain the use of a tapping jig.




COMMON FORM OF HYDROSTATIC LUBRICATOR

4. (a) Classify files as to (a) shape, (b) coarseness, (c) grooves, and (d) use.

5. (a) What methods are now approved by the National Electric Code?

(b) What kind of conductors can be used with molding under the Code requirements?

(c) Give the general Code requirements for inside wiring.

6. You are required to drill a 9-in. extra heavy flange. Diameter of bolt circle, 14 in.; number of 1-in. holes, 12. Explain how to lay out this work.

7. Name the principal parts of an engine lathe.

8. Describe 2 methods of lubricating steam engine cylinders. L. A. M.

### ANSWERS

CHUCKS are usually classified as drill chucks, lathe chucks, planer chucks, tapping chucks, etc.

(b) The advantages of each type depend upon its individual application to a certain kind of work.

(c) Some of the machine tools usually found in a well-equipped machine shop are: A set of turning and planing tools, a saw arbor, a lathe center, chuck jaw, milling cutters, twist drills, mandrel, reamers and taps.

2. (a) Hammers are commonly classified according to their trade application. Thus, we have the blacksmith's hammers of several shapes, of which the ball peen type is the most common. Others are: The machinist's, the boilermaker's, the shoemaker's, and the common claw hammer used by carpenters.

(b) Chisels may be classified as woodworking or metalworking chisels, and single or double bevel.

3. (a) In cutting a key-way, a cold chisel will answer the purpose. In shop practice, a square key-way is ordinarily cut on a planer with a key-way tool. For the Nordberg key, which is circular, a drill is employed.

(b) A tapping jig is used in manner similar to the ordinary jig. Care should be taken, however, to feed at proper speed in order to prevent stripping of the tap threads.

4. (a) Relative to shape, files may be classified as: Square, flat, mill, pillar, warding, round, put-saw, half-round, cabinet, double half-round, 3-cornered, cant, slitting or feather edge, and knife files.

(b) The degrees of coarseness of cut may be designated by the following terms: For single cut: Rough, middle, new cut, smooth float, second cut, and smooth. For double cut: Rough, middle cut, bastard cut, second cut, smooth double dead cut. For rasps: Horse, rough, middle, bastard, second cut, and smooth.

(c) There are 3 kinds of edges—single cut, double cut and rasp.

(d) The single cuts are largely used by sawyers for tooth-sharpening. Most files used by metal workers are double cut. Rasps are used by cabinet makers, carvers, farriers and core makers.

5. (a) It is assumed that in this question you have reference to wiring methods. Open wiring with either knobs or cleats, concealed knob and tube wiring and concealed and open conduit wiring are all approved by the Code.

(b) With wooden moulding single-braided rubber covered wire is required and no joints or splices are permitted except at outlets or at fittings. The same wire may be used in metal moulding, but must be laid in—not fished.

(c) The general requirements vary with the different methods employed in interior wiring and are too lengthy to be here given. A copy of the code may be obtained upon application to Chicago Board of Fire Underwriters, 175 West Jackson Blvd., Chicago, Ill.

6. Place a wooden plug in the flange in order to provide a center point. With a sharp pointed compass pivoted at the center point of the flange, inscribe the bolt circle with a 7-in. radius. Now, with the same radius lay off arcs on the bolt circle, and these arcs

will exactly divide the bolt circle into 6 equal arcs. Bisecting these arcs will give 12 equidistant points which will serve as center points for the holes to be drilled.

7. An engine lathe has a bed, a carriage with cutting tool, a head stock, back gear, cone, face plate, tailstock, feed screw or lead screw.

8. In the force feed method, oil is taken from the reservoir, usually by gravity, and after passing through a sight feed glass is forced by a pump into a small pipe in the steam supply. The pump may be directly driven by the engine or may operate as an independent pump.

In the hydrostatic system of lubrication, as illustrated in the accompanying sketch, the lubricator is filled with oil by removing cap K, the height of oil appearing in glass L. If water is present the oil floats on top, as indicated; after the cap is screwed in place the valves in the condenser pipe are opened, subjecting the oil in the vessel to steam-pipe pressure. Steam is condensed in pipe C, filling tube B and part of C, thus adding to the steam pressure—the pressure due to the weight of the water column. Valve F, which communicates with the top of the vessel by means of tube A, is opened wide as is also the regulating valve, I. The pressure at B being greater than that at A by the amount equivalent to the height of the water column, forces the oil through A and the "sight feed," S, to the steam pipe. The rate of flow is controlled by the regulating valve, I. As the oil flows from the vessel its space is occupied by condensed steam. W. P.

## Drying Compressed Air

AIR USED for etching electric light globes is delivered into a tank in the basement of the building at a pressure of from 20 to 25 lb. From this tank it is carried to a smaller tank on the fourth floor and thence through a 2-in. header feeding 4 1½-in. sand blast lines.

It is of great importance that no moisture reach these machines and I wish, therefore, that you would kindly tell me how to dry this air. P. McN.

A. In small installations there is little that can be done economically to secure dry air at the nozzle other than by the installation of tanks, such as you have in your line.

A precaution, however, is to be sure that the discharge outlet from these tanks is taken from the top so that none of the moisture which may collect near the bottom of the tank will be carried on to the air jet.

These tanks act as separators and should be drained occasionally, as circumstances require. In some large installations it is customary to refrigerate the air before it enters the air compressor, thus reducing the amount of moisture to a minimum, so that after the air has expanded at the outlet nozzle no moisture will be present.

Another provision which also tends to reduce moisture and at the same time increase the power available in compressed air, is that of installing re-heaters. These raise the temperature of the air just before it is used, so that, during expansion in the tool, the temperature does not reach much below that of the atmosphere and with the precaution mentioned above of taking the outlet pipes from the top of the storage tanks, this arrangement will, in most cases, insure dry air. R. E. T.

## Preventing Wear of Wooden Gear Teeth

IN OUR sugar factory we have an iron tooth gear meshing with one having wooden teeth, which have given us considerable trouble, due to their rapid wear. These gears operate in a warm place, and one in which they come in contact with much sugar dust.

Is there any preservative you could recommend using to lengthen their lives? Would treating them with hot linseed oil help matters any? R. S.

A. We do not believe that soaking or impregnating your wood teeth of the gear would help at all against the grinding, or cutting out of these teeth. The only thing for which a liquid preservative is of any value, is to prevent decay. The only thing which can prevent wearing would be something to harden the wood, and any liquid preservative would not do this. Encasing the gears would, of course, keep out the dust.

If you chose to go to the expense, probably teeth made of rawhide or of compressed silk or linen, as made by the General Electric Co. for certain pinions, might be longer lived and would give the same freedom from noise that is obtained by the wooden teeth.

The only other remedy would be the use of a metal toothed gear, which, of course, would mean a good deal more noise. A. L. R.

## Operation of Condensing Engines

KINDLY give me directions for operating condensing engines. I have never operated any but high-speed noncondensing engines. D. W.

A. Condensing steam engines operate practically the same as noncondensing engines, except that instead of the exhaust steam being forced out of the cylinder it is drawn out by the vacuum formed in the condenser. This reduced pressure created by the condenser not only causes the steam to flow out of the cylinder, but also acts on the piston, increasing the available mean effective pressure, which, of course, also means an increase in developed horsepower.

For detailed information regarding the theory and practice of steam-engine condensers, see pages 76 and 101, Jan. 1, 1916, issue of Practical Engineer.

When starting a condensing engine it is necessary first to have the condenser operating properly and the desired degree of vacuum established. Then open the exhaust valve of the engine carefully, noting the effect this may have on the vacuum; should the vacuum drop considerable, speed up the condenser pump. The throttle valve may then be opened and the engine slowly brought up to speed.

Should the condenser pumps have been speeded up during this time, slow them down again to such a speed as will just maintain the proper vacuum.

When shutting down, first close the engine throttle, then the engine exhaust valve, and lastly stop the condenser. O. H. H.

PLANS ARE UNDER WAY for the installation of a power plant in the Eighth Ward Memorial Hospital, Johnstown, Pa., the plan to furnish heat for the hospital building, steam and power for the laundry, and to have a refrigeration installation to care for the needs of the hospital. Plans are being prepared by a Baltimore engineer.

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## Editorial Comments

Institutions or industries developed on public capital, as a rule, are the results of popular demand and as such reflect the ideas of "the people" as to what is the most recent good practice along that line. We may look at the plant serving the state buildings at Springfield, Ill., in this light. Uniflow engines, cross-drum water-tube boilers, chain grate stokers, chain bucket coal conveyors, vacuum exhaust steam heating from a central plant, all represent the most modern practice for the purpose. Nothing has been omitted that is essential to safe and economical operation, and in the selection of the engines and the use of high pressure and superheated steam the engineers have indicated the trend of the times. While the equipment of this plant is in no way an experiment, owing to the peculiar load conditions, the results to be obtained will be watched with interest.

The third and last article of the series on engine governors by Mr. Wells appears in this issue. This series has dealt with the subject in such a manner that it would be of greatest value to the operating engineer preparing to take an examination for license. It gives the construction and principles of operation of the principal types of governors without going into the details of design which are the work of the factory designing engineer.

Mr. Thompson's article on foundations brings forth the question, "Why is a foundation?" And the answer he infers is "Merely to maintain alinement and give proper rigid support." Incidentally, however, in ordinary power plant practice, foundations are expected to absorb a reasonable amount of vibration due to the inability of the manufacturer to secure perfect balance or the extra expense necessary to reach that refinement. In other words, defects in the construction of machines may frequently be covered up by employing a heavy foundation.

That coal is considered a more reliable fuel for power plants than fuel oil, even in the southwestern oil regions, is the information gained through an investigation carried on by the National District Heating Association. Although fuel oil is more economical in some cases, furnaces are, as a rule, built for use of both oil and coal. These facts and others concerning the use of fuel oil are brought out in the article entitled "Notes on Fuel Oil."

The geographical location of a boiler has little to do with the safety of its construction or operation. What is safe practice in Massachusetts is equally safe in California, Wisconsin or Louisiana. In a paper read at the Ohio Boiler Inspectors Convention, the principal parts of which are given, Thomas E. Durban pointed out why there should be uniformity in inspection as well as construction of boilers.

Many of our troubles with electrical machinery are due to operating it under conditions for which it was not designed. Frequently comparatively slight changes in winding or construction will adapt the machine to the condition encountered. A number of the most common circumstances are discussed by H. L. Smith in this issue.

When repairing electrical machinery it is necessary to consider mechanical, electrical and magnetic effects which will be brought about by the repair; a few kinks given in this issue may help to relieve a difficult situation as rapidly as possible.

In the operation of internal combustion engines nothing is more important than the securing of proper carburetion. The proper mixing of air and vapor or gases is a sensitive operation and requires care and thought. To those not thoroughly familiar with the methods employed, Edward E. Dean's article on the subject should make clear many causes of trouble with internal combustion engines.

Another flywheel explosion from an unknown cause emphasizes still further the need of protective devices in all plants. In this case an engineer's life would have been saved by an engine stop. Where are our engine laws for the safety of men?

The letters from engineers which are published in this issue are rich in suggestions for the man in charge of the operation of a plant. Every letter is a practical idea which has helped someone out of trouble; why not profit by others' experiences?

Your heating season is coming on and you may have had troubles similar to those explained by our correspondent who was helped by the reply from Mr. Balcom. At any rate you should know the why of just such troubles and the answer is clear in its explanation.

Those Practical Reference Tables of this issue are convenient for finding at a glance the proper size wire and fuse for various sizes of induction motors. Unless all the employes know these sizes, these tables placed in the store room for ready reference will save time and may avoid serious errors.

# News Notes

GEORGE B. TRIPP, vice-president of the Harrisburg Light & Power Co., was elected president of the Pennsylvania Electric Association.

THE NORTHWESTERN Electrical Co., of Grand Forks, N. D., has been awarded the contract for the installation of a power plant at Erskine, Minn.

JOHN PAYTON, Novinger, Mo., and others, who own mining property nearby, are reported in the market for coal-mining equipment and a power plant.

THE PUBLIC SERVICE commission lately granted authority to the Calumet Electric Co., of Gary, Ind., to issue $65,000 in bonds for the purpose of constructing a high tension transmission line from its central station in East Gary to Crown Point. The total value of the proposed improvement will be approximately $55,000, the order said.

LEIGH STANLEY BACHE, of Bound Brook, N. J., First Vice-President and General Manager of the Bound Brook Oil-less Bearing Co., died at the Muhlenberg Hospital on Sept. 21. He was the son of Capt. Wm. H. Bache, was born near Jamestown, N. Y., in 1870, and became associated with the Bound Brook Co. in 1889. He was a member of many fraternal orders, of the Engineer's Club and the Salamungundi Club of New York. He is survived by a widow and 2 brothers.

SESSIONS at Lewis Institute, Chicago, opened for the autumn term on Sept. 18 for the day courses, and on Oct. 9 for the evening courses. The day courses include Mathematics, Sciences and Engineering, also Languages, Drawing and Domestic Economy. The evening courses, which meet on the evenings of Monday, Tuesday, Wednesday and Thursday, include the subjects of Engineering. Mechanic Arts, Mathematics, Chemistry, Domestic Economy and English. In co-operation with the concrete building industry a thorough course in concrete construction has been instituted. The evening courses particularly are designed to give practical instruction to those already engaged in the various industries, each course calling for attendance 2 evenings in the week.

THE COMMITTEE of the American Uniform Boiler Law Society, which has been busily engaged in furthering the interests of the A. S. M. E. Boiler Code, reports that the Legislature of Louisiana has passed a bill authorizing the Governor to appoint a commission of 5 experts to examine the Code and report to the Assembly in 1918 for or against the adoption of this Code into law by the state of Louisiana. The work of securing the passage of this bill through the Legislature is largely due to the good offices of Prof. E. W. Kerr of the Louisiana State University.

The committee further reports that the Purchasing Department of the Panama Canal, through its engineer, Major E. A. Brown, has recently sent out specifications for a boiler in the Canal Zone, requiring the construction and installation to be in accordance with the A. S. M. E. rules. Alternate bids are to be considered on other classes of boilers, but the form of the specifications would indicate that Major Brown considers the boiler built according to the A. S. M. E. Code superior to other boilers.

Chairman Thomas E. Durban also reports that at a convention at Columbus Aug. 17, favorable action was taken by the Ohio authorities looking toward the formulation of a Uniform Code for boiler inspection, the effort being to secure the adoption of such code in all states for inspection work. The meeting, which was of Ohio boiler inspectors, largely favored a uniform code for construction as well as for inspection.

Indications are also favorable that recommendations for boiler legislation in New York will be in the line of adopting the A. S. M. E. Code.

In Michigan, a campaign is being conducted under the direction of John C. McCabe, Chief Boiler Inspector of Detroit, looking toward the securing of support for the A. S. M. E. Code by the legislators of the state.

Effort to renew the funds of the Association is also under way, the endeavor being to get the same amount pledged for the support of the work of the Uniform Boiler Law Society as was pledged last year.

Good work has been done by the Society, especially by its chairman, and it is certainly to be hoped that the friends of uniform boiler laws will give to this Society the support which it deserves.

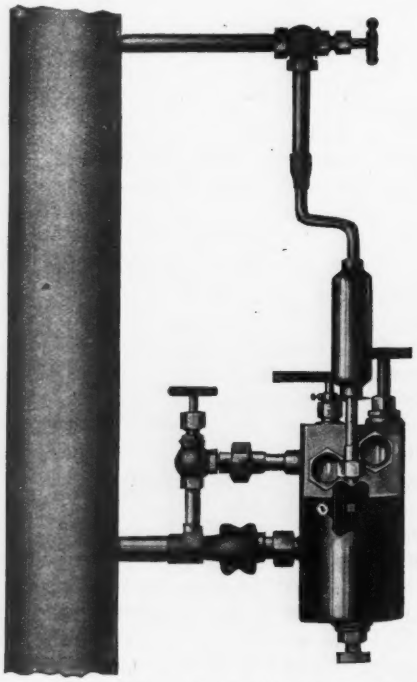
# Power Apparatus in Shop and Market

*New Ideas In Making, Buying and Selling*

## New Hydrostatic Grease Lubricator

ANOTHER step forward in the manufacture of grease lubricators has recently been made by The Ohio Grease Co., of Loudonville, Ohio. The new lubricator is shown herewith, and is known as Class F. It is a drop feed instrument, and differs from former models in the following points:

Steam for heating and atomizing purposes is taken from the delivery valve instead of from the lead line. A new ball valve is used for delivery instead of the globe valve type formerly used. All valves are equipped with cool fiber wheels. Sight glasses in the feed chamber are of new design and extra heavy. Lead line may be of any length desired.



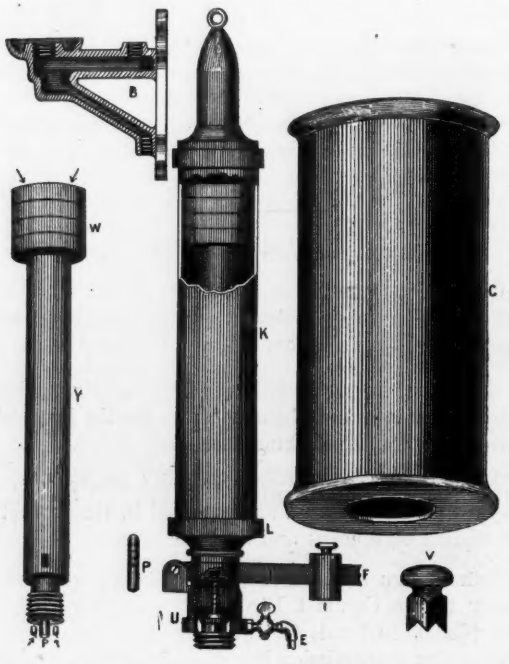
CLASS F LUBRICATOR FOR OHIO CYLINDER GREASE

This lubricator keeps the grease hot, and divides a pound or pint of it into 22,000 tiny drops. It then superheats and expands each drop as it passes through the feed chamber, delivery valve, etc., and delivers it into the steam line in such condition that it is instantly atomized or vaporized.

Thus the passing steam is lubricated, and deposits a thin, uniform coating on everything with which it comes in contact. The amount of lubricant required is greatly reduced, and there is no surplus or waste to carry over with the exhaust. The system is in use on all sizes and classes of steam units.

## Improved Automatic Kellum Steam Damper Regulator

DISTINCTIVE features of this damper regulator are its simplicity and its adaptability to control 2 or 3 separate dampers at different angles within any reasonable distance. It is made entirely of steam metal with no rubber or leather diaphragm, springs or packing and as stated by the manufacturers, Hess & Barker, 236 So. 8th St., Philadelphia, it will save from 10 to 25 per cent of fuel, depending upon the amount of heating and grate surface of the boiler, and will control pres-




COMPONENT PARTS OF KELLUM STEAM DAMPER REGULATOR

sures up to and including 175 lb. gage. The size of the regulator depends entirely upon the size and weight of the dampers to be controlled, regardless of the number or capacity of the boilers.

Referring to the cut, it will be seen that the instrument consists of piston Y upon which is a projecting ground joint, W, provided with water packing grooves. Over this works an accurately fitted cylinder, K, covered

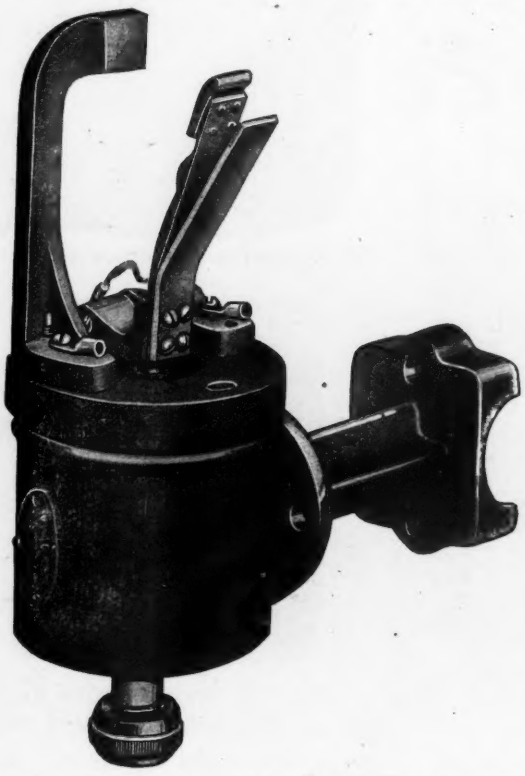
by a sleeve, C, weighing from 12 to 50 lb., according to the size of the machine. To the bottom of the piston is screwed section U containing valve V on a raised seat; upon this valve rests stem P, the top of which supports weighted lever F.

Chains operating the dampers are attached to the ring at the top of cylinder K.

Operation of the regulator is as follows: Weight I (from 1¼ to 1½ lb.) is so adjusted on lever F, that valve V will open at the pressure which it is desired to carry on the boiler. Steam entering ports Q and Q passes through piston Y and gradually raises cylinder K until cap L comes in contact with the bottom of ground joint W, at which time the damper is entirely closed. As the boiler pressure lowers, valve V is pressed to its seat by weighted lever F and as the condensation passes from within the piston through pet cock E, the cylinder descends, drawing the damper open.

## Instantaneous Direct-Current Solenoid Control Relay

SOLENOIDS for operating large carbon-break or oil circuit breakers frequently require comparatively heavy currents in closing solenoids. In such cases, the contacts of the solenoid control switch which controls the operation of the solenoid, not suited to operate the closing solenoid and it is necessary to use, also, a control relay with its operating coil excited by the closing contacts of the control switch and the relay contacts in series with the closing solenoid.



GENERAL ELECTRIC TYPE P FORM B-45 INSTANTANEOUS SOLENOID RELAY

A recently developed control relay, made by the General Electric Co., is in use for this purpose. The relay consists essentially of a solenoid, plunger and contacts with a metallic connection, consisting of a small flexible lead, between the movable contact arm and its support. The contacts are kept clean by a wiping motion each time the relay is operated. The relay may be closed by hand, by means of an insulated button on the lower end of the relay plunger.

## Two Improved Forms of Electrolytic Lightning Arresters

AS A RESULT of research work, which is carried on continuously for the purpose of increasing the efficiency of electrolytic lightning arresters, the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa., has made several improvements in its line of such apparatus and now offers the 2 forms illustrated, designated as types A and AK. The type A arrester is designed for voltages up to 2450 and is furnished for indoor mounting only; the type AK is for operation on alternating current at 2000 v. and above, particularly where generators are to be protected.

As the change in resistance is instantaneous with the change in voltage, the electrolytic lightning arrester offers a very high resistance to the flow of current at normal voltages and very low resistance to current at abnormal voltages. It also acts as a condenser, so that its effective resistance to current at low or normal frequencies is great, but to currents at high or abnormal frequencies of static disturbances, it is small. These 2 properties are due to films electrochemically deposited on aluminum trays in the arrester.

While designed for direct current service in railway or lighting power houses and substations, the present form of type A arrester with spark gap may be used for low-voltage alternating current installations. It is similar in construction to the type AK, except that no charging resistance is required. The same aluminum trays are used, and these are mounted in an iron tank of ample strength, and of such size as to provide sufficient oil for cooling purposes under all possible operating conditions. It is not limited to any particular kilowatt capacity of circuit. It is furnished with a fuse mounted on top of the tank with a gap for insulating the arrester from the line. This gap can be easily short-circuited for charging purposes, which operation should be performed once a day. The arrester can be operated on direct current with the gap closed; but in this case the leakage current disintegrates the aluminum trays and the electrolyte, giving them a much shorter life than when a gap is used.

Type AK arrester consists of a system of nested, aluminum, double cone or cup-shaped trays, supported on porcelain and secured in frames of treated wood, arranged in a steel tank. The system of trays is electrically connected between line and ground and between line and line. These trays contain a liquid electrolyte which forms a film on their surfaces, preventing flow of current at normal voltages but forming a free path for abnormal voltages or static discharges. Distinctive features about this arrester are: A new inorganic electro-

lyte of improved chemical stability, little affected by heat, which causes but slight dissolution of the film between charging periods; double cone-shaped aluminum trays, which are spaced by porcelain pieces and do not touch wood; ventilating duct in center of tray stack for additional circulation of oil; tank linings of bakelite micarta, impervious to moisture; charge and discharge resistance on all arresters, and fuses included.

For outdoor service, type AK arresters are the same as the indoor arresters, except that the outdoor arresters are provided on terminals. The outdoor arresters are not furnished for voltages of less than 10,000, as for voltages below this the horn gaps cannot, with safety, be set close enough together out of doors to take advantage of the freedom of discharge of the electrolytic element. If the horn gaps are set too close they are short-circuited by rain.

Horn gaps are furnished on all type AK arresters. They are readily adjustable for any line voltage and so arranged that the bridging necessary for charging is easily accomplished. On indoor arresters, for voltages below 9900 v., bridging is accomplished by tilting one horn of each pair until a phosphor bronze strip attached to each movable horn comes in contact with the corresponding horn and short circuits the gap. A spring insures the return of the movable horns to their normal position after charging. For charging arresters on circuits of 10,000 v. and higher, the proper adjustment of the gap is obtained by setting a stop on the horizontal bar that turns one of each pair of horns about on its own axis. When properly adjusted for operation, the horns are slightly offset. When the arresters are to be charged, the horns are swung back until they are in the same plane. When opened to their widest extent, the horns serve as a disconnecting switch and insure safety to those working about the arrester.

Charge and discharge resistance connected between the main horn gap and the arrester proper is furnished with all type AK arresters. Those resistance units consist of rod resistors in shunt with small spark gaps. The resistor is of a composition known as "Koppat," and possesses the quality of remaining practically uniform under all conditions of service. Shunt gaps are between small horns. In the low voltage arresters, one resistance rod and one shunt gap are used, and in the higher voltage arresters, two of each are used in series.

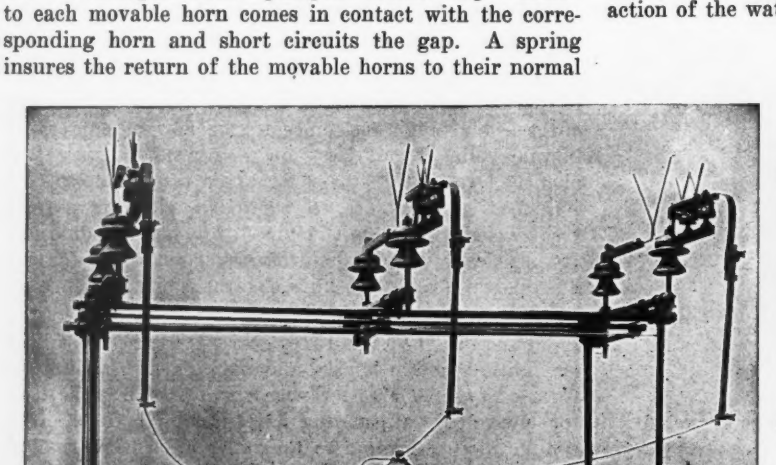
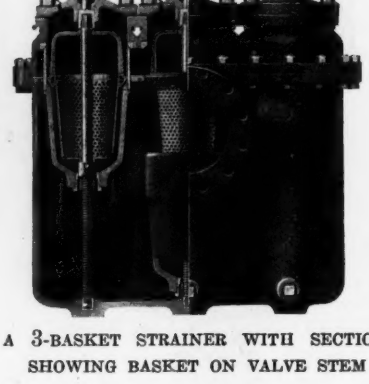


FIG. 2. TYPE AK ARRESTER

## Multiple Basket Water Strainer

ONLY one large valve to each strainer basket is used in the Holt multiple basket strainer, and as this valve normally occupies a position on the strained water side of the strainer, out of the direct flow of the water, the valve seat is not subjected to the cutting action of the water.

FIG. 1. WESTINGHOUSE TYPE A ARRESTER



A 3-BASKET STRAINER WITH SECTION SHOWING BASKET ON VALVE STEM

All passageways through the strainer have 20 per cent greater area than the inlet or outlet area of the pipe line, and with one basket out of commission, the remaining area of the straining baskets is never less than 2½ times the area of the inlet. These large areas

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly will

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PRACTICAL ENGINEER

TABLE I—SINGLE-PHASE, 110-VOLT INDUCTION MOTORS

| Hp | Full Load, Amp | Starting Fuse, Amp | Wire Sizes, B. & S. Gage | |
|---|---|---|---|---|
| | | | Rubber Ins. | Other Ins. |
| 1 | 13.3 | 35 | 8 | 10 |
| 2 | 24.8 | 65 | 6 | 8 |
| 3 | 36. | 90 | 4 | 6 |
| 4 | 47.2 | 125 | 2 | 3 |
| 5 | 58.4 | 160 | 0 | 2 |
| 7½ | 85.2 | 225 | 00 | 0 |
| 10 | 110. | 300 | Circ. Mil 200,000 | 00 |
| 15 | 162. | 400 | 300,000 | 0000 |

—Western Association of Electrical Inspectors.

PRACTICAL ENGINEER

TABLE III—TWO-PHASE, 110-VOLT, FOUR-WIRE MOTORS

| Hp | Full Load, Amp | Starting Fuse, Amp | Wire Sizes, B. & S. Gage | |
|---|---|---|---|---|
| | | | Rubber Ins. | Other Ins. |
| 1 | 6.01 | 20 | 14 | 14 |
| 2 | 11.2 | 35 | 10 | 12 |
| 3 | 14.7 | 50 | 8 | 8 |
| 4 | 21.6 | 70 | 6 | 8 |
| 5 | 28.6 | 90 | 4 | 6 |
| 7½ | 38.8 | 100 | 3 | 5 |
| 10 | 50.2 | 130 | 1 | 2 |
| 15 | 73.4 | 190 | 0 | 1 |
| 20 | 95. | 250 | 000 | 0 |
| 25 | 118. | 310 | 0000 | 00 |
| 30 | 138. | 360 | Circ. Mil 300,000 | 000 |
| 35 | 162. | 430 | 350,000 | 0000 |
| 40 | 182. | 480 | 400,000 | Circ. Mil 250,000 |
| 50 | 224. | 590 | 500,000 | 350,000 |
| 60 | 268. | 700 | 650,000 | 450,000 |
| 75 | 332. | 890 | 900,000 | 600,000 |

—Western Association of Electrical Inspectors.

PRACTICAL ENGINEER

TABLE V—TWO-PHASE, 440-VOLT, FOUR-WIRE MOTORS

| Hp | Full Load, Amp | Starting Fuse, Amp | Wire Sizes, B. & S. Gage | |
|---|---|---|---|---|
| | | | Rubber Ins. | Other Ins. |
| 1 | 1.51 | 5 | 14 | 14 |
| 2 | 2.8 | 10 | 14 | 14 |
| 3 | 4.6 | 15 | 14 | 14 |
| 4 | 5.4 | 20 | 12 | 14 |
| 5 | 7.15 | 25 | 12 | 14 |
| 7½ | 9.7 | 25 | 12 | 14 |
| 10 | 12.5 | 30 | 10 | 12 |
| 15 | 18.35 | 45 | 8 | 8 |
| 20 | 23.75 | 60 | 6 | 8 |
| 25 | 29.5 | 80 | 5 | 6 |
| 30 | 34.5 | 90 | 4 | 6 |
| 35 | 40.5 | 100 | 3 | 5 |
| 40 | 45.5 | 120 | 2 | 3 |
| 50 | 56. | 135 | 1 | 2 |
| 60 | 67. | 180 | 0 | 1 |
| 75 | 83. | 200 | 00 | 0 |
| 100 | 109. | 290 | Circ. Mil 200,000 | 00 |
| 125 | 134. | 370 | 300,000 | 000 |
| 150 | 160. | 420 | 350,000 | 0000 |
| 175 | 183.5 | 490 | 400,000 | Circ. Mil 300,000 |
| 200 | 209. | 550 | 450.000 | 350,000 |

—Western Association of Electrical Inspectors.

PRACTICAL ENGINEER

TABLE VII—THREE-PHASE, 220-VOLT INDUCTION MOTORS

| Hp | Full Load, Amp | Starting Fuse, Amp | Wire Sizes, B. & S. Gage | |
|---|---|---|---|---|
| | | | Rubber Ins. | Other Ins. |
| 1 | 3.5 | 10 | 14 | 14 |
| 2 | 6.5 | 20 | 12 | 14 |
| 3 | 9.5 | 30 | 10 | 12 |
| 4 | 12.5 | 40 | 8 | 10 |
| 5 | 15.4 | 50 | 8 | 10 |
| 7½ | 22.4 | 60 | 6 | 8 |
| 10 | 29. | 75 | 4 | 8 |
| 15 | 42.5 | 100 | 3 | 6 |
| 20 | 55. | 140 | 2 | 4 |
| 25 | 68. | 175 | 0 | 2 |
| 30 | 80. | 200 | 0 | 2 |
| 35 | 94. | 250 | 00 | 1 |
| 40 | 105. | 275 | 000 | 0 |
| 50 | 130. | 350 | Circ. Mil 250,000 | 000 |
| 60 | 155. | 400 | 300,000 | Circ. Mil 200,000 |
| 75 | 192. | 500 | 400,000 | 300,000 |
| 100 | 252. | 650 | 600,000 | 400,000 |
| 150 | 368. | 1000 | 1,000,000 | 700,000 |
| 200 | 484. | 1200 | 1,400,000 | 900,000 |

—Western Association of Electrical Inspectors.

TABLE IV—TWO-PHASE, 220-VOLT, FOUR-WIRE MOTORS

| Hp | Full Load, Amp | Starting Fuse, Amp | Wire Sizes, B. & S. Gage | |
|---|---|---|---|---|
| | | | Rubber Ins. | Other Ins. |
| 1 | 3.02 | 10 | 14 | 14 |
| 2 | 5.6 | 20 | 14 | 14 |
| 3 | 7.35 | 25 | 12 | 14 |
| 4 | 10.8 | 30 | 10 | 12 |
| 5 | 14.3 | 40 | 8 | 10 |
| 7½ | 19.4 | 50 | 8 | 8 |
| 10 | 25.1 | 60 | 6 | 8 |
| 15 | 36.7 | 90 | 4 | 6 |
| 20 | 47.5 | 125 | 2 | 3 |
| 25 | 59. | 150 | 1 | 2 |
| 30 | 69. | 180 | 0 | 1 |
| 35 | 81.3 | 200 | 00 | 1 |
| 40 | 91. | 240 | 000 | 0 |
| | | | Circ. Mil | |
| 50 | 112. | 300 | 200,000 | 00 |
| 60 | 134. | 350 | 250,000 | 000 |
| | | | | Circ. Mil |
| 75 | 166. | 440 | 350,000 | 250,000 |
| 100 | 218. | 580 | 500,000 | 350,000 |
| 125 | 268. | 700 | 650,000 | 450,000 |
| 150 | 320. | 850 | 850,000 | 550,000 |
| 200 | 418. | 1100 | 1,200,000 | 800,000 |

TABLE II—SINGLE-PHASE, 220-VOLT INDUCTION MOTORS

| Hp | Full Load, Amp | Starting Fuse, Amp | Wire Sizes, B. & S. Gage | |
|---|---|---|---|---|
| | | | Rubber Ins. | Other Ins. |
| 1 | 6.65 | 25 | 12 | 14 |
| 2 | 12.4 | 30 | 10 | 12 |
| 3 | 18. | 50 | 8 | 8 |
| 4 | 23.6 | 65 | 6 | 8 |
| 5 | 29.2 | 80 | 4 | 6 |
| 7½ | 42.6 | 120 | 2 | 3 |
| 10 | 55. | 150 | 1 | 2 |
| 15 | 81. | 220 | 00 | 0 |

TABLE VIII—THREE-PHASE, 440-VOLT INDUCTION MOTORS

| Hp | Full Load, Amp | Starting Fuse, Amp | Wire Sizes, B. & S. Gage | |
|---|---|---|---|---|
| | | | Rubber Ins. | Other Ins. |
| 1 | 1.75 | 5 | 14 | 14 |
| 2 | 3.25 | 10 | 14 | 14 |
| 3 | 4.75 | 15 | 14 | 14 |
| 4 | 6.25 | 25 | 12 | 14 |
| 5 | 7.7 | 25 | 12 | 14 |
| 7½ | 11.2 | 30 | 10 | 12 |
| 10 | 14.5 | 40 | 8 | 10 |
| 15 | 21.2 | 50 | 8 | 8 |
| 20 | 27.5 | 65 | 6 | 8 |
| 25 | 34. | 90 | 4 | 6 |
| 30 | 40. | 100 | 3 | 5 |
| 35 | 47. | 125 | 2 | 3 |
| 40 | 52.5 | 150 | 1 | 2 |
| 50 | 65. | 175 | 0 | 1 |
| 60 | 77.5 | 200 | 0 | 1 |
| 75 | 86. | 250 | 000 | 0 |
| 100 | 126. | 325 | 0000 | 000 |
| | | | Circ. Mil | Circ. Mil |
| 150 | 184. | 500 | 400,000 | 200,000 |
| 200 | 242. | 640 | 550,000 | 400,000 |

TABLE VI—THREE-PHASE, 110-VOLT INDUCTION MOTORS

| Hp | Full Load, Amp | Starting Fuse, Amp | Wire Sizes, B. & S. Gage | |
|---|---|---|---|---|
| | | | Rubber Ins. | Other Ins. |
| 1 | 7. | 25 | 12 | 14 |
| 2 | 13. | 40 | 8 | 10 |
| 3 | 19. | 60 | 6 | 8 |
| 4 | 25. | 80 | 5 | 6 |
| 5 | 30.8 | 100 | 4 | 5 |
| 7½ | 44.8 | 120 | 2 | 3 |
| 10 | 58. | 150 | 1 | 2 |
| 15 | 85. | 225 | 00 | 0 |
| | | | Circ. Mil | |
| 20 | 110. | 300 | 200,000 | 00 |
| 25 | 136. | 360 | 250,000 | 000 |
| 30 | 160. | 430 | 350,000 | 0000 |
| | | | | Circ. Mil |
| 35 | 188. | 500 | 400,000 | 300,000 |
| 40 | 210. | 560 | 450,000 | 350,000 |
| 50 | 260. | 680 | 600,000 | 400,000 |
| 60 | 310. | 820 | 800,000 | 550,000 |
| 75 | 381. | 1000 | 1,000,000 | 700,000 |

greatly reduce the velocity of the water through the strainer baskets, allowing sufficient time for settling and insuring that the solid matter will not be forced through the perforated basket.

From 2 to 8 baskets are provided to each strainer, the number being proportioned to the effective straining area required. The size of the mesh can be made to suit conditions, and where it is desirable to remove the smallest particles, the standard basket may be provided with an inner basket containing a large number of very small openings.

The strainer basket is supported and held rigid by the valve stem operating the valve which encloses the basket. Any up and down movement is prevented by the fixed collar on the bottom of the valve stem supporting the bottom of the basket, and the socket stem extension which extends downward and engages the upper portion of the basket handle. The outer rim of the basket is provided with a ring-shaped holder which is recessed to provide a grooved way for the collapsible and expanding segments. Each segment is operated by a small coiled bronze wire spring which is enclosed and removed from the path of the liquid flowing through the strainer basket.

Bronze seats are fitted on the strainer bonnet, so that by turning the valve screw with the hand wheel, the enclosing valve is raised, and, coming in contact with the collapsible segments, flushes them back into the recessed groove around the holder. Thus sufficient clearance is provided to allow the valve to continue upward and seat itself against the valve seat in the bonnet.

A ported bushing is used at the bottom of the enclosing valve to serve as a clean-out valve when the enclosing valve is in its lowest position, and when the liquid is flowing through the perforated strainer basket, the flow is directed toward the bottom of the valve, washing out any mud or sand which may accumulate there.

This strainer is suitable for both vacuum and pressure work and has given satisfactory results when working in horizontal, vertical or any angular position.

The Holt strainer is made by the Rosedale Foundry & Machine Co., Pittsburgh, Pa.

# Book Reviews

MECHANICAL TECHNOLOGY, by G. F. Charnock; 635 pages, 503 illustrations; New York, 1915. Price, $3.

It has been the aim of the author of this volume to bring together a connected and systematic account of the chief operation underlying mechanical trades and handicrafts for the benefit of students, apprentices and regular workers in such industries. It is, of course, not to be expected that any description of work shop tools and processes can possibly take the place of actual experience in their use. But it is a fact that when "going through the shops" young engineers rarely devote sufficient time to the foundry or smith's shop, although a knowledge of the operations there carried on is of paramount importance to the designer and constructor. Scarcely less desirable is an acquaintance with the methods of the rolling mill, or of the possibilities of stamping, drawing, etc., processes which are much neglected by the majority of engineers.

The volume is divided into 3 parts, the first of which considers the production and properties of the chief materials of construction; the second, processes depending upon the property of fusibility, while the third is devoted to those processes which depend upon the properties of malleability and ductility.

Two chapters are given over to the discussion of special materials used for mechanical purposes such as oils, lubricants, leather, India rubber and gutta percha—their properties and uses.

ELECTRICAL TABLES AND ENGINEERING DATA, by H. C. Horstmann and V. H. Tousley; 331 pages, 34 illustrations and 132 tables; first edition; Chicago, 1916. Price, $1.

In order to furnish electricians generally and others engaged indirectly in electrical work, with a reference and table book which can be conveniently carried in the pocket, this volume has been prepared. It contains no theoretical discussions and its scope is limited to practical information which is daily called for by electrical workers. The matter is arranged in alphabetical order, thus enabling one to find the information desired without delay.

The most valuable feature of the book is the numerous tables contained therein, and while the majority of these are devoted to electrical work, a large proportion are of a general mechanical nature of service to master mechanics, machinists, engineers, etc.

THE BUREAU OF STANDARDS, Department of Commerce, has just published a paper which describes a new form of instrument for varying that property of an electrical circuit (self inductance) which opposes any change in the strength of a current, just as the inertia of a heavy train of cars opposes any change in its speed. It consists of 2 sets of coils of insulated wire mounted in circular hard rubber plates between which a similar plate carrying 2 coils is arranged to turn, thus varying the inductance. Diagrams and data are given from which instruments of this type may be designed to meet the requirements of a given use. Comparison is made of the new instrument and of older ones.

Copies of this report, Scientific Paper No. 290, may be obtained without charge upon application to the Bureau of Standards, Washington, D. C.

STEAM POWER, by C. F. Hirshfeld and T. C. Ulbricht, first edition, 1916; New York. Price, $2.

In this book the authors have endeavored to collect in a comparatively small book information on such parts of the field of steam power as should be familiar to engineers whose work does not require that they be conversant with the more complicated thermo-dynamic principles considered in advanced treatments. Mathematical treatment of the subject has been eliminated to the greatest possible extent, and anyone familiar with elementary algebra should be able to understand readily such equations as it has been deemed necessary to include. The book should prove serviceable as a text for steam power courses in industrial schools, and for anyone desiring a home reading course on this subject.

The first chapters deal with elementary subjects such as physical conceptions and units, the heat-power plant, steam, the ideal steam engine, entropy diagram, temperature entropy diagrams and steam cycles. It then takes up the study of the actual steam engine, explaining its operation, cause of losses, effects of clearance, determination of initial condensation, classification of steam engines, engine nomenclature and principal parts of engines. Following this is a chapter on the indicator diagram and derived values, another on compounding; others on the D-slide valve, Corliss and other high efficiency engines, regulation, the steam turbine, condensers and related apparatus, combustion, fuels, steam boilers, recovery of waste heat, and boiler feed pumps and other auxiliaries.

Illustrations and diagrams are used freely to bring out the principles and construction explained in the text matter, and following each chapter is a set of problems to show the application of the principles explained in the preceding text matter. The book is thoroughly up to date, illustrating and describing the most recent types of power plant apparatus and should be of considerable value, particularly to those just starting in the profession.

ELECTRIC MOTORS, by D. P. Moreton; 241 pages, 115 illustrations and tables; first edition; Chicago, 1916. Price, $1.

While apparently the author had in view the needs of the practical man brought into daily contact with the care and operation of direct- and alternating-current motors, this book ought also to prove of value to the beginner in the study of electrical engineering.

No more mathematics than is absolutely essential for a clear understanding of the subject has been introduced and that which of necessity is employed is accompanied by explanatory notes which will readily aid the student in overcoming any difficulty encountered.

The subject in general is presented in an exceedingly clear and practical manner.

The first 3 chapters treat of the fundamental principles of electric and magnetic circuits. Chapter 4 treats of the common methods of measuring current flow, pressure, resistance and power, and only such methods are given as will be found serviceable to the practical man. Chapters 5 and 9 are devoted to a treatment of armature windings for both direct and alternating-current motors, particular attention being given to defining the common terms and numerous diagrams which are presented to illustrate the points in question. The different types of direct-current motors, their construction, operating characteristics, speed control, location, repair of troubles, etc., are taken up in Chapters 6, 7 and 8. Chapters 10, 11 and 12 are devoted to a treatment of the different types of alternating-current motors, along the same general lines as in the case of direct-current motors. A number of examples are given throughout the book, which will serve to illustrate the application of certain relations and principles, and in this manner assist the reader in obtaining a clear understanding of their value in practical work.

AN EXTENSIVE STUDY of the methods employed in the preparation of bituminous coal at Illinois mines has been made by the Engineering Experiment Station of the University of Illinois. The data and information, which have required several years to compile, have been tabulated and analyzed by Professor E. A. Holbrook, and are now published as Bulletin 88 of the Engineering Experiment Station.

The results are subdivided into, (a) Evolution of present preparation practice, (b) Standard types of tipples or preparation plants, (c) Impurities and breakage of coal, making preparation necessary, (d) Sizing and sizes of Illinois Coal.

A record is presented of the yearly production of the different sizes of coal in Illinois over a period of 35 yr., agreements between operators and miners as affecting preparation are discussed, and requirements for standardization are studied.

Copies of Bulletin 88 may be obtained upon application to W. F. M. Goss, Director, Urbana, Ill.

INDUSTRIAL ARITHMETIC, by N. L. Roray; 154 pages, 86 illustrations, cloth binding; Philadelphia, 1916. Price, 75 cents.

This text is intended primarily to assist those in technical or trade schools or in industrial shops where problems arise which involve an elementary knowledge of geometry in their solution. In simple language the lessons explain the characteristics of angles and polygons. Methods are illustrated for computing the areas and finding the volumes of different surfaces and solids. The subjects of tapers, thread cutting, cutting speed and feed, and speeds of pulleys and gears are clearly presented, and problems are offered in woodworking and forge shop practice. Examples are given illustrating the methods outlined for extracting square roots, factoring, and use of fractions and decimal equivalents.

EXAMPLES IN ALTERNATING-CURRENTS, by F. E. Austin, 5 by 7½ in., 223 pages; second edition, 1916.

This book was written for the purpose of aiding college students to a thorough understanding of the subject of alternating currents, and as such assumes that the reader has a well grounded knowledge of mathematics up to and including calculus, as well as college physics. The book will be found valuable as a supplement to a regular text on alternating currents and an aid to teachers in assigning exercise problems to students.

## Catalog Notes

INCRUSTATION, CORROSION, FOAMING and other effects of water used in steam making are subjects treated in a new booklet published by the Dearborn Chemical Co. of Chicago. Its chapters show how the Dearborn organization has discovered the cause and worked out the remedy for all ill effects produced by the action of water on the boiler metal.

THE INGERSOLL-RAND CO., 11 Broadway, New York, recently issued 3 new bulletins as follows:

Form 9024 contains 32 pages on the fundamental principles of steam condensing plants in minute detail, making comparisons of the Beyer Barometric Counter-Current Condenser with low level jet condensers and

surface condensers. All auxiliary apparatus, such as vacuum pumps and centrifugal water pumps, are illustrated and described in detail.

Form 4122 describes the IR Model Leyner Drill Sharpener. To those interested in properly formed and sharpened bits, this bulletin will be of timely interest, as it explains and illustrates the sharpener in detail and shows the various styles of bits.

Form 3033 describes Imperial "XPV" Duplex Steam Driven Compressors, produced to meet a universal demand for a steam-driven air compressor designed and constructed to operate satisfactorily under high pressures and superheat as well as under ordinary steam conditions. The catalog shows the various sizes and capacities and explains in detail the operation of the "Imperial" Piston Valve.

Copies of these bulletins will be mailed free on request.

ELLISON DRAFT GAGES, manufactured by Lewis M. Ellison, 214 W. Kinzie St., Chicago, are illustrated and described in a pamphlet recently issued.

DE LA VERGNE Machine Co., 1172 E. 138th St., New York, has issued a new circular illustrating the single-cylinder De La Vergne oil engine.

CLARAGE Kalamazoo multiblade fans are described and capacity tables made up from actual performance tests are given in Catalog No. 5 of Clarage Fan Co., Kalamazoo, Mich.

THE WHITACRE feed water meter, for automatically weighing and recording the water fed to boilers, is the subject of a circular from R. B. Whitacre & Co., St. Paul, Minn.

BULLETIN NO. 200, fully describing Engberg direct connected, alternating current generating sets, was recently received from Engberg's Electric & Mechanical Works, St. Joseph, Mich.

POWER EFFICIENCY from the Boss' Viewpoint is the title of a short story published in pamphlet form by the Republic Flow Meters Co., of Chicago. The executive, the auditor and the engineer are the characters, their aim is to proportion power costs, the story tells how they did it.

THE NEW CATALOG of Warren Webster & Co., Camden, N. J., entitled The Webster System of Steam Heating, contains 144 pages giving a complete description of the Webster System and also gives information on Webster feed-water heaters and heater-meters, Webster air conditioning apparatus, Webster steam and oil separators, and other Webster steam specialties.

TWO OF H. W. Johns-Manville Co.'s new catalogs were recently received, one describing Johns-Manville Transite Asbestos Shingles for the attention of the home owner and architect, the other on Johns-Manville Corrugated Asbestos Roofing, for the particular attention of engineers, architects, contractors and builders. Both catalogs contain many illustrations to show the use of these materials on different types of buildings.

BUREAU OF MINES announces the following new publications, a limited supply being available for free distribution: Bulletin 105, Black damp in mines, by G. A. Burrell, I. W. Robertson and G. G. Oberfell; Bulletin 116, Methods of sampling delivered coal, and specifications for the purchase of coal for the Government, by G. S. Pope; Technical Paper 102, Health Conservation at steel mills, by J. A. Watkins; Technical Paper 151, Coke-oven accidents in the United States during the calendar year 1915, compiled by A. H. Fay; Technical Paper 159, Production of explosives in the United States during the calendar year 1915, with notes on coal-mine accidents due to explosives, and list of permissible explosives, lamps, and motors tested prior to June 1, 1916, compiled by A. H. Fay; Technical Paper 161, Construction and operation of a single-tube cracking furnace for making gasoline, by C. P. Bowie. Requests for all papers can not be granted. Publications should be ordered by number and title. Address applications to the Director of the Bureau of Mines, Washington, D. C.

THE LAGONDA Manufacturing Co.'s latest booklet on Lagonda Boiler Room Specialties is a concise catalog of all the specialties in the Lagonda line, containing illustrations of the different types of Lagonda tube cleaners, etc., and is sent upon request to any engineer addressing the company at Springfield, Ohio.

THE FLOW OF WATER in Wood-Stave Pipe is the title of a new Professional Paper of the U. S. Department of Agriculture, Department Bulletin No. 376, by Fred C. Scobey, irrigation engineer. The bulletin is based upon the results obtained through a large number of experiments on the flow of water in wood-stave pipes ranging from 8 in. to 13½ ft. in diameter. The work also included the collection and analysis of available records of all previous experiments of a similar character. From the results of all experiments made, there has been deduced a new set of formulas for the flow of water in stave pipes, which is presented in the bulletin.

The bulletin is highly technical in character, and its distribution is limited to engineers and others concerned with the use of wood pipe for conveying water for irrigation, power, municipal, mining, and similar purposes. Application for the bulletin should be addressed to the U. S. Department of Agriculture, Washington, D. C.

HOW TO SELL an Idea is the title of an interesting handbook on electric cooking just published by the Society for Electrical Development. It is intended for electric range salesmen and those contemplating range campaigns. Society members are receiving it this week. To others it will be mailed free upon request.

A surprising fact developed recently in analyzing rates for electric cooking of 5c and under in 3300 communities. It was found that, contrary to the general impression, 1884 communities in the eastern part of the country have cooking rates as against 1260 in the western part. In other words, 624 more eastern communities have a 5c or less cooking rate than in the far west where hydroelectric power is so well developed.

The society will soon have ready for distribution another booklet on electric cooking, this one for the public. It sells electric ranges from a new angle—just as the society has done in its new salesmen's booklet, How to Sell an Idea.

The society as an organization has taken the lead in electric range campaign educational work largely because it is so well equipped to handle its many intricacies. It stands ready to assist members with special services, a welcome adjunct to its publication work.

PIPE FITTERS' TOOLS are illustrated, together with price lists, in a new booklet from Walworth Mfg. Co., of Boston, Mass.

THE EVERLASTING VALVE with the straight through blow is made the subject of a new booklet published by Scully Steel & Iron Co., of Chicago. These valves meet the demands wherever a quick opening and closing valve is required and the booklet illustrates a number of these special uses.

FROM THE OHIO BRASS CO., Mansfield, Ohio, we have received Valve Catalog No. 51, superseding Valve Catalog No. 50. This latest issue contains 144 pages dealing with the company's complete line of brass valves and steam specialties, and by the liberal use of cuts and text, fully describing in a clear, concise and comprehensive manner the subject matter.

## Trade Notes

THE SARCO CO., Inc., has recently been successful in obtaining contracts for the supply of radiator traps for several important buildings in Detroit, among others the Detroit Evening News Building, the Lavard Hotel, and the National Bank of Commerce Building.

THE NAME of the firm heretofore known as G. L. Simonds & Co. has been changed to Vulcan Fuel Economy Co. to give a better idea of the scope of its business. There is no change in personnel, policies or location, but the capital has been increased to handle the growing business.

EVENING INSTRUCTION in Mechanical Drawing is to be offered by the Ohio Technical Drawing School, Columbus, O., courses began on Oct. 3. Classes may later be formed in Mechanics and Strength of Materials, Mechanism and Machine Design. Sessions will be held at 1348½ N. High St.

THE BUTTE & SUPERIOR Copper Co. has purchased from the Westinghouse Electric & Mfg. Co. of East Pittsburgh, Pa., a flywheel motor-generator, direct-current hoisting equipment. Similar equipments have also been sold to the United Verde Co., Jerome, Ariz., and the Hercules Mining Co.

MANY DYES and chemicals heretofore procured exclusively abroad, which cannot now be imported, are being successfully made in this country, as it only needed this stimulus of necessity to meet such exigency.

Among these products was Sulphuret of Antimony which is used largely for imparting color to rubber goods.

A very high grade of Sulphuret of Antimony—both Crimson and Golden—is now being produced by the Magnolia Metal Co. at their Matawan, N. J., smeltery; said to be equal in every respect, if not superior, to any similar product, and The St. George Chemical Co., of New York, has been appointed exclusive selling agent for that product.


# PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

SEMI-MONTHLY

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

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Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.



## ADVERTISING RATES

### Display

Full page, one year, each insertion, $60.00.

Half page, one year, each insertion, $35.00.

Quarter page, one year, each insertion, $20.00.

Eighth page, one year, each insertion, $12.00.

Front cover $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

### Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

### Technical Publishing Co.

537 S. Dearborn Street

Chicago

**Position Wanted**

POSITION WANTED—Young man, age 28, as engineer in New York or Brooklyn. Hold marine, stationary and refrigeration license. Day work, 8-10 hours, desires to go to school nights. Write for particulars. Box 452, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 10-1-2

POSITION WANTED—Young man wishes position as oiler or assistant engineer in a plant in New York City. Two years' practical experience. Write William Brand, 24 Locust Hill Ave., Yonkers, N. Y. 10-1-2

POSITION WANTED—As master mechanic, superintendent, chief engineer or erecting engineer. Have practical and technical experience in designing, erecting and operating central stations, power transmission and distributing systems, refrigerating and ice making plants and saw mills. For years connected with the largest machinery importing and engineering house in the Orient as estimator, selling and erecting engineer. Have traveled extensively, both in the Orient and Latin Americas. Know the Spanish and Italian languages. Have executive ability and can produce results. Will accept position to go anywhere for party offering proper inducements. Box 451, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 10-1-2

STEAMFITTER—Accustomed to high pressure work wants permanent situation. American and strictly sober always; am not afraid of plenty of work. Can work from blue prints, as well as do all kinds of general repairs. Have some experience in millwright work and some knowledge of steam engineering. H. L. Simonds, Box 166, Sac City, Iowa.

POSITION WANTED—Chief engineer, experienced on Steam Turbines and Condensers, Corliss and Automatic Engines, A.C. and D.C. Generators, Transformers and Meters. Have built and operated plants with my own capital. Have Ohio First Class Engineer's license Issue No. 6. Will be at liberty in 30 days or before if necessary. Will come on one month's trial to prove my ability. Age 30. Address J. A. Wise, Mowrystown, Ohio. 10-15-1

POSITION WANTED—I am a thoroughly competent power plant engineer, accustomed to handling on high efficiency basis all types of steam engines and turbines, A.C. and D.C. machines; strictly sober; 34 years old; married. Want charge of good plant in Chicago that will pay at least $25.00 per week. Address Box 455, Practical Engineer, 537 S. Dearborn St., Chicago. 10-15-1

POSITION WANTED—Young, sober and reliable married man, as engineer. Six years' experience with a.c. and d.c. compression ice plants, Corliss, high speed and slide valve engines. Ambitious. Desire change where advancement is possible. Open October 1st. R. Bruce, Caruthersville, Mo. 10-15-1

## Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. ft.

WANTED—Young man for assistant engineer in medium sized packing house, to keep records, drafting, tests, etc.; some knowledge of theory desirable. Good opportunity for I. C. S. student. Address Box 445, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 9-1-4

WANTED—Energetic chemist for assistant plant superintendent in large Dyestuff Factory west of Buffalo. Good salary and excellent opportunity for right man. Application should give fullest details regarding experience and also references. Address Box 456, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 10-15-1

WANTED—Sober, reliable engineer to take charge of small electric light and ice plant combined. Permanent position. Married man preferred. Edina Light Co., Edina, Mo.

## Wanted

AGENTS WANTED for a power plant specialty. Territory east of Philadelphia not available. Merit of apparatus assured beyond a doubt. Our proposition to agents exceedingly attractive. Flynn & Emrich Co., Baltimore, Md. 9-1-4

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Well versed boiler ant combustion salesman or established engineering agents to sell complete line of mechanical stokers, natural and forced draft; also steam jet ash handling system, on liberal commission lines. Box 453, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 10-1-4

WANTED—As partner, man with a little money and a lot of push, to take office end of steam specialty of superior merit and a necessity in every plant. A square deal for the man who becomes my partner and extra value for our customers. Investigate. Box 458, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Motor Generator Set: 3-phase, 60 cycle, 550-volt motor, 30 to 50 K.W. 125-volt generator. Address Box 457, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 10-15-1

## For Sale

FOR SALE—75-hp. Westinghouse, 2-cylinder steam engine in first-class shape; weight about 8000 lbs. Send for particulars. J. L. Lucas & Son, Bridgeport, Conn. 9-15-3

FOR SALE—18x42 Allis belted engine in thoroughy good condition. Double eccentrics. Steel lagging. Box 454, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 10-1-2

GAS ENGINE FOR SALE—One 15-hp. 2-cylinder Westinghouse gas engine for sale in good condition. No reasonable offer refused. Correspond with E. B. Latham & Co., 4 Murray St., New York City. 10-15-6

## Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F. St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x.

PATENTS—Send sketch for free search and reports. Books and patents and book of reference letters sent free. John S. Duffie & Co., 612 F. St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

## Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time, to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

## Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chiiago, Ill. tf.

# *Sparks From The Advertising Pages*

## The Renaissance of Advertising

The following is part of a thesis prepared by a graduating student of the University of Missouri and delivered as his senior oration. While reading it, it is well to keep in mind the part the subject of advertising is taking in the scholastic life of the colleges. Only a few years ago advertising was not included in the curriculum of any university.

When one nation, finding itself in the midst of a world-war, appeals to the patriotism of its citizens through the medium of the advertising page; when another, hovering closely upon the brink of war, calls upon advertising to disseminate plans of national defense; when churches throughout the land, in an effort to extend their sway of influence, use the advertising columns of the newspaper to urge religious faith; when vast moral and political issues invoke the aid of advertising—then advertising takes on a new significance and becomes something more than a powerful business force.

At the outbreak of the raging conflict across the water, Great Britain found herself woefully in need of men. The government called upon an advertising expert, who was instrumental in recruiting men during the Boer War, and the result of the conference was an advertising campaign that added thousands to the depleted English army.

Only a few months ago, a great cry arose throughout the United States for preparedness. Out of this cry grew the dominating political issue of the day. Gradually, the crystallization of public opinion took place; and the contending parties used as the organs for moulding public sentiment the advertising pages of the national periodicals. In double-page spreads, the friends of Theodore Roosevelt extolled his merits as a candidate for the presidency, while Henry Ford pointed out the folly of the preparedness program in the same manner.

In an entirely neutral vein, the engineering societies of the country have offered their services to the Government in compiling statistics concerning the manufacturing resources of the nation, while the public at large is being brought into sympathy with this work through advertising placed by the Associated Advertising Clubs in magazines and newspapers that reach even the smallest hamlet in America.

So powerful is the moral influence of this association of advertising clubs that they have been urged by an inspired writer of the new advertising era, Gerald Stanley Lee, to take the lead in the solution of the present world problems. "I look to the advertising men of America," he says, "to seize the war as their billboard and smite on it a true picture of what America really is. The soul of advertising is the soul of America. The spirit of all our more characteristic American inventions seems to be this advertising spirit of not letting things happen but of taking them in hand and of making them happen."

Ten thousand advertising writers, publishers, managers, have allied themselves in this great association of advertising clubs, and have emblazoned the one word *Truth*, not only upon their emblem, but upon their hearts as well. They are striving to rid advertising of the odious stamp of dishonesty which disgraced its early development.

The courts of the land are recognizing this new spirit in advertising. A late verdict of the Supreme Court has made it unlawful even to exaggerate the truth in advertising. Nor is it enough to give full money's worth. In the recent case of a Florida land company, it was found that the plaintiff had been led to expect more than he received, and though the land in question was reasonably worth the amount paid for it, the plaintiff was awarded his suit, and the advertising condemned as fraudulent, because it was exaggerated.

What is the significance of all this? What does it all mean? In the words of President Wilson, "It augurs permanence and stability in our industrial and distributive methods because it means good business judgment; and more than that, it indicates a fine conception of public obligation on the part of men in business, a conception which is one of the inspiring things in our outlook upon the future of national development."

Who can read these lines without feeling a new respect for this mighty force in the economic and social life of our nation. And who can read the decision of the Supreme Court without feeling a deep sense of security in buying advertised goods.